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technical memo

Date:	2 August 2024
To:	Vicki Robins, Graymont (NSW) Pty Ltd
From:	Andrew Butler and Natalie Chandra, Epic Environmental
Client name:	Graymont (NSW) Pty Ltd
Project name:	Calliope Limestone Quarry
Project number:	BAA220011.01
Subject:	Calliope Waste Rock Characterisation

1 INTRODUCTION

Epic Environmental Pty Ltd (Epic) has been engaged by Graymont (NSW) Pty Ltd (Graymont) for the continuation of environmental approvals support for their Calliope Limestone Quarry (the Project). The Project is located at Taragoola, Queensland (QLD).

The work has been undertaken to satisfy and information request from the QLD Department of Environment and Science and Innovation (DESI – previously Department of Environment and Science, DES) following submission of the Progressive Rehabilitation and Closure Plan (PRCP) for Calliope.

2 BACKGROUND

Graymont holds a site-specific Environmental Authority (EA) (reference: EPML00969013), enabling mining activities to be undertaken at their Calliope site.

The PRCP application was prepared in accordance with the Queensland Government's *Environment Protection Act 1994* (EP Act) and the *Mineral and Energy Resources (Financial Provisioning) Act 2018* (MERFP Act). The application was initially submitted to DESI on 16 March 2023 and determined to be *Not Properly Made*, with a subsequent submission on 27 June 2023 determined by the DESI to be *Properly Made,* with an accompanying Information Request (IR) Notice received on 7 August 2023. The IR Notice identified information gaps or clarifications that need to be addressed for DESI to approve the PRCP. In particular, DESI identified gaps in waste rock characterisation.

A waste rock characterisation for the limestone quarry is therefore required to address the PRCP IR_1[1]. It would also be suitable to support an amendment to the EA. The submission date for the amended PRCP is 30 August 2024.

3 MATERIAL BEING CHARACTERISED

Waste rock from the mining operation has been placed on two (2) main waste rock dumps (WRDs), which have been labelled with the prefixes “northern” (NWRD) and “southern” (SWRD). The locations of the WRDs are shown on **Figure F1.**

Waste rock across the WRDs includes overburden, poor quality limestone (low specification, high clay fines content, such as that visible on the SWRD), andesite, greywacke (fault rock), and conglomerate. Of the sampled materials, andesite is considered to be the only rock exposed in the void wall to have any potential for acid generation and mixed andesite or andesite dominated waste was targeted during sampling.

[1] The waste rock characterisation presented herein may also be used to support an EA amendment to reflect and expansion of mining activities at Calliope.

Production bench blast drill chips have also collected from mining benches to characterise the main 'ore' exposed in the void walls. Similarly, samples of product stockpiled at the site were also analysed for mineralogy.

4 METHODOLOGY

The following section summarises the sampling methodology completed by staff from Graymont under the direction of Epic (refer **Section 4.1.1**) and the laboratory analysis undertaken.

4.1 Sampling

Sampling was completed for the northern and southern WRDs and production bench blast drill chips. Limestone (i.e., the rock which makes up a majority of the exposed void) was also sampled from blast drill holes on a production bench in the pit (refer **Section 4.1.2**).

4.1.1 Waste Rock Dumps

Graymont provided Epic with the current volumes of the WRDs which are summarised in **Table 1**. Given the low risk of acid generation, the sample density aimed to collect a minimum of one sample per 100,000 m^3 of waste rock.

Table 1. Waste rock dump volumes and samples

WRD ID	Estimated volume (m^3)	Number of bag samples collected	Number of jar samples collected	Sample IDs
NWRD	1,090,600	11	11	NW-S1-W NW-S2-W NW-S3-S NW-S4-S NW-S5-E NW-S6-E NW-S7-E NW-S8-TOP 1 NW-S9-TOP 2 NW-S10-TOP 3 NW-A (Andesite)
SWRD	850,100	10	10	SW-S1-S SW-S2-S SW-S3-S SW-S4-S SW-S5-S SW-S1-N SW-S2-N SW-S3-N SW-S4-N SW-F

The sampling methodology implemented by Graymont is provided in **Table 2**.

Table 2. Waste rock sampling methodology

Action	Description
Soil sampling	An excavator was used to obtain samples at various depths throughout the stockpiled material.
Sample collection	Samples of the material were collected directly from the excavator bucket using nitrile gloves. Material was screened using a 20 mm diameter sieve to obtain a homogenous sample and remove any large rock particles. Samples were placed into laboratory-supplied 150 mL glass jars (with Teflon-lined lids) for chemical analysis and 500 mL plastic zip-lock bags for acid-base accounting analysis.

Action	Description
	Samples were labelled and immediately stored on ice in eskies for transportation to the National Association of Testing Authorities (NATA) accredited laboratory (ALS Environmental Pty Ltd (ALS)).
Sample labelling, storage and transport	Samples were clearly labelled with unique sample identification numbers. Samples were kept chilled in an ice-filled esky prior to dispatch and during transport to the primary laboratory under chain-of-custody (COC) procedures.
Cross contamination	The excavator bucket was the only piece of equipment reused between sample points during the sampling. Samples were collected from the centre of the excavator bucket to minimise cross-contamination. A new pair of disposable nitrile gloves was worn for the collection of each sample.

4.1.2 Blast Drill Chips

A total of three (3) rock samples (DRILL-S1-S, DRILL-S2-N, DRILL-S3-M) were collected from a production bench associated with the drill cores/rock chips from the Project's exploration mining activities.

Samples were collected in the same containers and followed the same storage/transport methodology mentioned in **Table 2**.

4.1.3 Additional Product Stockpile

Petrographic (mineralogy and chemistry) analysis was previously commissioned by Graymont for product/stockpiled material including gabion rock, aggregate rock, and road base rock (Geochempet Services 2023, Groundwork Plus 2023, Groundwork Plus 2022, Superior Quarry Testing 2023). This data provides further evidence for the nature of the materials exposed in the pit walls and has been used in the assessment of acid mine drainage (AMD) potential.

4.1.4 Laboratory Analysis

Laboratory analysis for acid base accounting suite of static tests was completed by a NATA-accredited laboratory (ALS) to screen for AMD potential of the waste rock and void wall material. The following analysis was completed for each sample:

- Net Acid Producing Potential (NAPP), which includes Acid Neutralising Capacity (ANC) reported as $CaCO_3$ and H_2SO_4, fizz rating, and total sulfur (by LECO)
- Net Acid Generation (NAG)
- Chromium Reducible Sulfur (Scr) as a measure of sulfur present as sulfide
- Sulfate sulfur
- Laboratory certificates are provided in **Appendix A**.

The petrographic analysis conducted on samples of product material included mineralogy, carbonate, sulfide and chloride content. The reports are attached in **Appendix B**.

5 DATA ANALYSIS AND INTERPRETATION OF RESULTS

5.1 Acid Mine Drainage Potential

Acid base accounting was undertaken to determine the potential for waste samples to be acid generating. A summary of the analytical results for the assessed acid base characteristics is provided in **Table 3**.

Table 3. Waste rock analytical results – acid base accounting and sulfur characterisation

		ANC	Fizz rating	NAPP	NAG pH (Ox)	Max Potential Acidity (MPA)[2]	Net Potential Ratio (NPR)[3]	NAG (pH 4.5)	NAG (pH 7)	Total S	Scr	Sulfate (SO_4^{2-})
Location	**Laboratory ID**	kg H_2SO_4 /t	-	kg H_2SO_4/t	pH unit	kg H_2SO_4 /t	-	kg H_2SO_4/t	kg H_2SO_4/t	%	% S	mg/kg
Southern WRD	SW-S1-S	999	5	-998	11.5	0.61	1632	<0.1	<0.1	0.02	0.009	180
	SW-S2-S	564	5	-563	9.9	0.61	922	<0.1	<0.1	0.02	0.006	<100
	SW-S3-S	779	5	-778	9.5	0.61	1273	<0.1	<0.1	0.02	0.012	<100
	SW-S4-S	984	5	-983	11.5	0.61	1608	<0.1	<0.1	0.02	0.009	120
	SW-S5-S	575	5	-575	10	0.31	1879	<0.1	<0.1	0.01	0.009	<100
	SW-S1-N	821	5	-820	11.1	0.61	1342	<0.1	<0.1	0.02	<0.005	110
	SW-S2-N	897	5	-897	10.9	0.31	2931	<0.1	<0.1	0.01	0.008	100
	SW-S3-N	578	5	-578	10.5	0.31	1889	<0.1	<0.1	0.01	<0.005	<100
	SW-S4-N	746	5	-746	10.8	0.31	2438	<0.1	<0.1	0.01	0.006	<100
	SW-F	738	5	-738	11.2	0.31	2412	<0.1	<0.1	0.01	0.006	<100
Blast Drill Chips	DRILL-S1-S	1030	5	-1030	11.2	0.61	1683	<0.1	<0.1	0.02	0.008	<100
	DRILL-S2-N	1020	5	-1020	9.5	1.22	833	<0.1	<0.1	0.04	0.036	<100
	DRILL-S3-M	1020	5	-1020	11	2.14	476	<0.1	<0.1	0.07	0.074	<100
Northern WRD	NW-S1-W	1000	5	-1000	11.5	0.31	3268	<0.1	<0.1	0.01	0.008	<100
	NW-S2-W	986	5	-986	11.4	0.31	3222	<0.1	<0.1	0.01	0.005	210
	NW-S3-S	886	5	-885	11.4	0.61	1448	<0.1	<0.1	0.02	0.012	<100
	NW-S4-S	1010	5	-1010	11.3	0.61	1650	<0.1	<0.1	0.02	0.008	<100
	NW-S5-E	516	5	-515	11.7	0.61	843	<0.1	<0.1	0.02	0.016	<100
	NW-S6-E	942	5	-942	11.4	0.31	3078	<0.1	<0.1	0.01	<0.005	<100
	NW-S7-E	1030	5	-1030	11.4	0.61	1683	<0.1	<0.1	0.02	0.013	<100
	NW-S8-TOP 1	173	3	-173	10.2	0.15	1131	<0.1	<0.1	<0.01	<0.005	<100
	NW-S9-TOP 2	1000	5	-1000	11.2	0.31	3268	<0.1	<0.1	0.01	0.006	<100
	NW-S10-TOP 3	923	5	-922	11.5	0.61	1508	<0.1	<0.1	0.02	0.006	<100
	NW-A	996	5	-995	11.6	0.61	1627	<0.1	<0.1	0.02	0.008	140

[2] MPA = Total S% x .30.6
[3] NPR = ANC/MPA

The results showed the following:

- Very low levels of total sulfur (<0.1%) across all three locations, which, from the SCr test, appeared to be in the form of sulfides
- Strongly negative NAPP values (markedly less than negative 20 kg H2SO4/t) across all three locations, indicating the material is acid consuming
- NAG pH values above 7 across all three locations
- NPRs markedly greater than 3 across all samples (INAP 2009)

Due to the very low total sulfur concentrations, there is no need to further account for the different forms of sulfur present (such as oxidised forms of sulfur; sulfates) to improve the assessment of AMD risk.

NAG pH and NAPP have been plotted on **Figure 1**. All of the data confirms that the waste rock and production (drill chip) material is classified as **non-acid forming (NAF)** (AMIRA 2002).

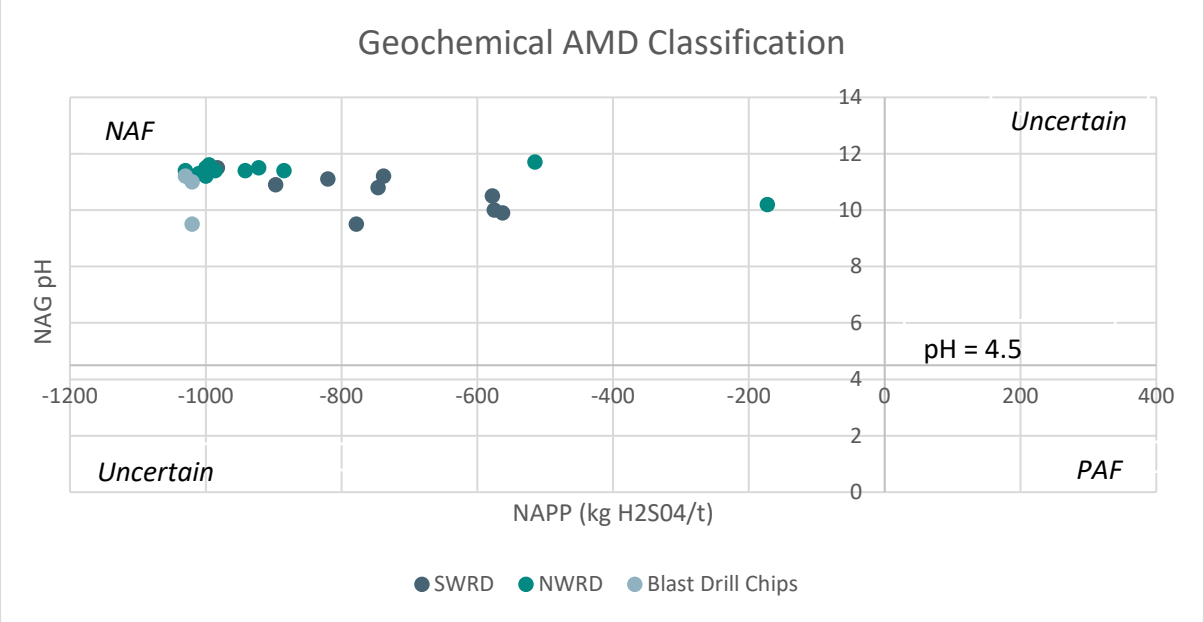


Figure 1. Geochemical AMD classification plot for the three locations based on NAG pH and NAPP (AMIRA 2002)

5.2 Petrographic Analysis

The petrographic analysis completed in 2023 has shown that the limestone rock produced at Calliope is 93%-99% calcite (calcium carbonate) with the balance being goethite (iron oxide-hydroxide). The analysis also indicated that sulfides were not observed in the samples.

Given that carbonate mineralogy of the material and the lack of observable sulfides, there is no risk of AMD generation from exposed limestone in the void wall.

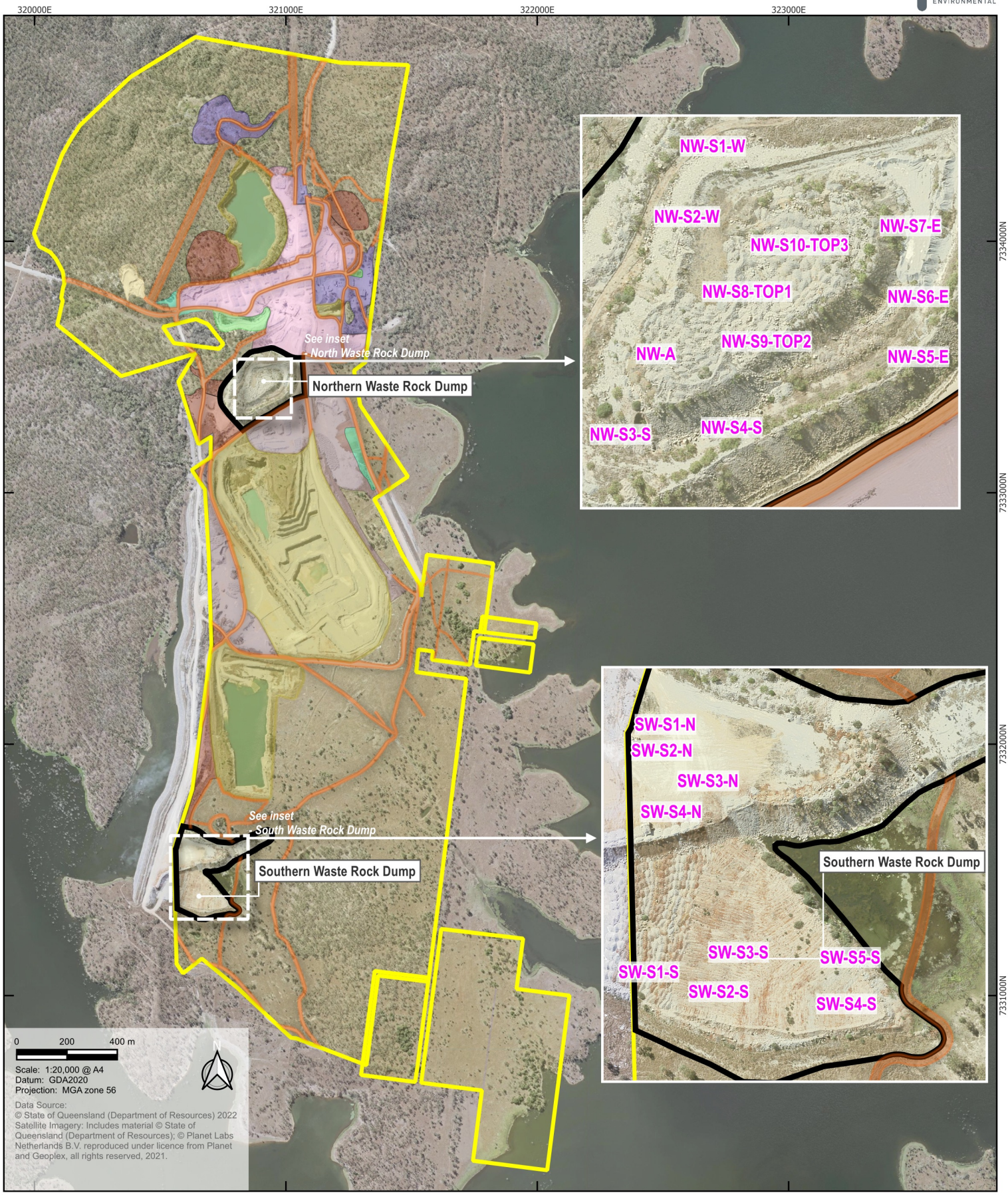
Additionally, the limestone contains negligible chloride. Together with the lack of AMD generation potential and the negligible risk of neutralisation salts formation, the results indicate a very low risk of saline mine drainage generation.

6 CONCLUSION

The materials described in this letter are categorised as **non-acid forming**. There is negligible risk of acid generation from the WRDs or exposed rocks in the void wall. The results are consistent with the geology of the Project and the lack of acid pH values in water quality results from water that collects in the void presented in the PRCP. No kinetic testing work is warranted.

7 REFERENCES

AMIRA, 2002. *Prediction & Kinetic Control of Acid Mine Drainage,* Melbourne: Environmental Geochemistry International.
INAP, 2019. *The GARD Guide,* Skelleftea: INAP.



Filepath: ~BAA\BAA220011.01 Graymont Calliope PRCP Stage 2\Workspaces\BAA220011.01 Waste Characterisation\2. Letter\Rev 0\Figure 1 Current disturbance area.qgz

Legend

- Site boundary
- **Current disturbane area**
- Waste rock dump
- Cleared areas and laydowns
- Infrastructure and plant
- Access tracks
- Sediment pond
- Pit
- ROM processing area
- Silt dump
- Temporary spoil storage area
- Topsoil stockpile
- SW-S3-S Waste characterisation samples

Graymont Limited
Calliope Limestone Quarry
Waste Characterisation Letter

Figure 1
Calliope limestone quarry - Waste rock dumps

APPENDIX A LABORATORY CERTIFICATES

CHAIN OF CUSTODY

ALS Laboratory: please tick →

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☐PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com
☐WOLLONGONG 1/19-21 Ralph Black Drive North Wollongong NSW 2500 Ph: 02 4225 3125 E: wollongong@alsglobal.com

CLIENT: Graymont Australia (GRAAUS)	TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g., Ultra Trace Organics)	☐ Standard TAT (List due date): ☐ Non Standard or urgent TAT (List due date):	FOR LABORATORY USE ONLY (Circle)
OFFICE: MS 24 Taragoola Rd Calliope Qld 4680			Custody Seal Intact? Yes No N/A
PROJECT: Waste Dump Characteristics - Calliope PROJECT NO.:	ALS QUOTE NO.: BN/130/17 V2	COC SEQUENCE NUMBER (Circle)	Free ice / frozen ice bricks present upon receipt? Yes No N/A
PURCHASE ORDER NUMBER: 833739	COUNTRY OF ORIGIN: Australia	COC: (1) 2 3 4 5 6 7	Random Sample Temperature on Receipt: °C
PROJECT MANAGER: Vicki Robins	CONTACT PH: (07) 4975 7144	OF: 1 (2) 3 4 5 6 7	Other comment:

SAMPLER: Vicki Robins	SAMPLER MOBILE: 0437 921211	RELINQUISHED BY: A. Jones	RECEIVED BY: GW 14.50	RELINQUISHED BY: GW 15.00	RECEIVED BY: DM
COC Emailed to ALS? (YES / NO)	EDD FORMAT (or default):	DATE/TIME: 14/1/50. 30.04.24	DATE/TIME: 30.4.24	DATE/TIME: 30.4.24	DATE/TIME: 1020 2/5/24
Email Reports to : vicki.robins@graymont.com					
Email Invoice to : calliopesales@graymont.com					

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL: ~~PLEASE LOG AS A PLANNED EVENT~~

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES + BAGS	Fluoride - Total	ICP/AES: 1st Metal (includes digestion) (Sb)	Mercury - Total Recoverable	- SCR (CRS)	NAPP (includes ANC, Total S)	Net Acid Generation (NAG)	Sulfate - Total as SO_4		Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	SW-S1-S	30.04.2024 @ 8.25am	SOIL		2	X	X	X	X	X	X	X		
2	SW-S2-S	30.04.2024 @ 8.45am	SOIL		2	X	X	X	X	X	X	X		
3	SW-S3-S	30.04.2024 @ 8.39am	SOIL		2	X	X	X	X	X	X	X		
4	SW-S4-S	30.04.2024 @9.00am	SOIL		2	X	X	X	X	X	X	X		
5	SW-S5-S	30.04.2024 @9.00am	SOIL		2	X	X	X	X	X	X	X		
6	SW-S1-N	30.04.2024 @ 8.50am	SOIL		2	X	X	X	X	X	X	X		
7	SW-S2-N	30.04.2024 @ 9.10am	SOIL		2	X	X	X	X	X	X	X		
8	SW-S3-N	30.04.2024 @ 9.20am	SOIL		2	X	X	X	X	X	X	X		
9	SW-S4-N	30.04.2024 @ 9.40am	SOIL		2	X	X	X	X	X	X	X		
10	DRILL-S1-S	30.04.2024 @ 8.15am	SOIL		2	X	X	X	X	X	X	X		
11	DRILL-S2-N	30.04.2024 @ 8.15am	SOIL		2	X	X	X	X	X	X	X		
12	DRILL-S3-M	30.04.2024 @ 8.15am	SOIL		2	X	X	X	X	X	X	X		
				TOTAL	24									

Environmental Division
Brisbane
Work Order Reference
EB2414326

Telephone : + 61-7-3243 7222

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

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ALS Laboratory: please tick →

□ADELAIDE 2/1 Burma Road Pooraka SA 5095 Ph: 08 8162 5130 E: adelaide@alsglobal.com
□BRISBANE 2 Byth Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com
□GLADSTONE 46 Callemondah Drive Gladstone QLD 4680 Ph: 07 4978 7944 E: ALSEnviro.Gladstone@alsglobal.com
□MACKAY Unit 2/20 Caterpillar Drive Paget QLD 4740 Ph: 07 4952 5795 E: ALSEnviro.Mackay@alsglobal.com
□MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com
□MUDGEE 1/29 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com
□NEWCASTLE 5/585 Maitland Road Mayfield West NSW 2304 Ph: 02 4014 2500 E: samples.newcastle@alsglobal.com
□NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 02 4423 2063 E: nowra@alsglobal.com
□PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com
□SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsglobal.com
□TOWNSVILLE 14-15 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: ALSEnviro.Townsville@alsglobal.com
□WOLLONGONG 1/19-21 Ralph Black Drive, Nth Wollongong NSW 2500 Ph: 02 4225 3125 E: wollongong@alsglobal.com

CLIENT: Graymont Australia (GRAAUS)	TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g., Ultra Trace Organics) ☐ Standard TAT (List due date): ☐ Non Standard or urgent TAT (List due date):
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PROJECT: Waste Dump Characteristics - Calliope PROJECT NO.:	ALS QUOTE NO.: BN/130/17 V2
PURCHASE ORDER NUMBER: 833739	COUNTRY OF ORIGIN: Australia
PROJECT MANAGER: Vicki Robins	CONTACT PH: (07) 4975 7144
SAMPLER: Vicki Robins	SAMPLER MOBILE: 0437 921211
COC Emailed to ALS? (YES / NO)	EDD FORMAT (or default):
Email Reports to : vicki.robins@graymont.com	
Email Invoice to : calliopesales@graymont.com	

COC SEQUENCE NUMBER (Circle)

COC:	1	(2)	3	4	5	6	7
OF:	1	(2)	3	4	5	6	7

FOR LABORATORY USE ONLY (Circle)

Custody Seal Intact?	Yes	No	N/A
Free ice / frozen ice bricks present upon receipt?	Yes	No	N/A
Random Sample Temperature on Receipt:		°C	
Other comment:			

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
R. Songs.	GW 14.50	GW 15.00	
DATE/TIME: 30-04-24. 14/50	DATE/TIME: 30.4.24	DATE/TIME: 30.4.24	DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL: ~~PLEASE LOG AS A PLANNED EVENT~~

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL BOTTLES + BAGS	Fluoride - Total	ICP/AES: 1st Metal (includes digestion) (Sb)	Mercury - Total Recoverable	- SCR (CRS)	NAPP (includes ANC, Total S)	Net Acid Generation (NAG)	Sulfate - Total as SO_4		Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
13	NW-S1-W	30.04.2025 @ 9.50am	SOIL		2	X	X	X	X	X	X	X		
14	NW-S2-W	30.04.2025 @ 10.00am	SOIL		2	X	X	X	X	X	X	X		
15	NW-S3-S	30.04.2024 @ 10.10am	SOIL		2	X	X	X	X	X	X	X		
16	NW-S4-S	30.04.2024 @ 10.20am	SOIL		2	X	X	X	X	X	X	X		
17	NW-S5-E	30.04.2024 @ 10.30am	SOIL		2	X	X	X	X	X	X	X		
18	NW-S6-E	30.04.2024 @ 10.40am	SOIL		2	X	X	X	X	X	X	X		
19	NW-S7-E	30.04.2024 @ 10.45am	SOIL		2	X	X	X	X	X	X	X		
20	NW-S8-TOP 1	30.04.2024 @ 10.55am	SOIL		2	X	X	X	X	X	X	X		
21	NW-S9-TOP 2	30.04.2024 @ 11.10am	SOIL		2	X	X	X	X	X	X	X		
22	NW-S10-TOP 3	30.04.2024 @ 11.15am	SOIL		2	X	X	X	X	X	X	X		
23	NW-A	30.04.2024 @ 11.25am	SOIL		2	X	X	X	X	X	X	X		
24	SW-F	30.4.24 @9.50	SOIL.		2	X	X	X	X	X	X	X		
				TOTAL	24									

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
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CERTIFICATE OF ANALYSIS

Work Order	: **EB2414326**	Page	: 1 of 12
Client	: **GRAYMONT (AUSTRALIA) PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: Vicki Robins	Contact	: Customer Services EB
Address	: MS 24 TARAGOOLA ROAD CALLIOPE 4680	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: ----	Telephone	: +61-7-3243 7222
Project	: Waste Dump Characteristics - Calliope	Date Samples Received	: 02-May-2024 10:20
Order number	: 833739	Date Analysis Commenced	: 03-May-2024
C-O-C number	: ----	Issue Date	: 16-May-2024 17:54
Sampler	: Vicki Robins		
Site	: ----		
Quote number	: BN/130/17 V4		
No. of samples received	: 24		
No. of samples analysed	: 24		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Soil Preparation, Stafford, QLD
Dilani Fernando	Laboratory Coordinator	Melbourne Inorganics, Springvale, VIC
Jarwis Nheu	Non-Metals Team Leader	Melbourne Inorganics, Springvale, VIC
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ASS: EA033 (CRS Suite): Analysis is performed as per the Acid Sulfate Soils Laboratory Methods Guidelines (2004) and the updated National Acid Sulfate Soils Guidance: National acid sulfate soils identification and laboratory methods manual, Department of Agriculture and Water Resources, Canberra, ACT (2018)
- ASS: EA033 (CRS Suite):Retained Acidity not required because pH KCl greater than or equal to 4.5
- EK040T: EB2414326 #002 Poor matrix spike recovery for Total Fluoride due to sample matrix. Confirmed by re-extraction and re-analysis.
- ASS: EA033 (CRS Suite): Laboratory determinations of ANC needs to be corroborated by effectiveness of the measured ANC in relation to incubation ANC. Unless corroborated, the results of ANC testing should be discounted when determining Net Acidity for comparison with action criteria, or for the determination of the acidity hazard and required liming amounts.
- ASS: EA033 (CRS Suite): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime (CaCO3) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from 'kg/t dry weight' to 'kg/m3 in-situ soil', multiply 'reported results' x 'wet bulk density of soil in t/m3'.
- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	SW-S1-S	SW-S2-S	SW-S3-S	SW-S4-S	SW-S5-S
			Sampling date / time	30-Apr-2024 08:25	30-Apr-2024 08:45	30-Apr-2024 08:39	30-Apr-2024 09:00	30-Apr-2024 09:00
Compound	CAS Number	LOR	Unit	EB2414326-001	EB2414326-002	EB2414326-003	EB2414326-004	EB2414326-005
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-998**	**-563**	**-778**	**-983**	**-575**
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**11.5**	**9.9**	**9.5**	**11.5**	**10.0**
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**999**	**564**	**779**	**984**	**575**
ANC as CaCO3	----	0.1	% CaCO3	**102**	**57.6**	**79.5**	**100**	**58.7**
Fizz Rating	----	0	Fizz Unit	**5**	**5**	**5**	**5**	**5**
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**9.4**	**8.8**	**9.0**	**9.4**	**8.8**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.009**	**0.006**	**0.012**	**0.009**	**0.009**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	**101**	**49.0**	**74.5**	**100**	**49.5**
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	**20200**	**9790**	**14900**	**20100**	**9880**
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	**32.4**	**15.7**	**23.9**	**32.2**	**15.8**
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	SW-S1-S	SW-S2-S	SW-S3-S	SW-S4-S	SW-S5-S
				Sampling date / time	30-Apr-2024 08:25	30-Apr-2024 08:45	30-Apr-2024 08:39	30-Apr-2024 09:00	30-Apr-2024 09:00
Compound	CAS Number	LOR	Unit		EB2414326-001	EB2414326-002	EB2414326-003	EB2414326-004	EB2414326-005
					Result	Result	Result	Result	Result
EA033-E: Acid Base Accounting - Continued									
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		<10	<10	<10	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t		<1	<1	<1	<1	<1
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		**4.5**	**0.5**	**7.7**	**9.8**	**8.9**
ED040: Sulfur as SO4 2-									
Sulfate as SO4 2-	14808-79-8	100	mg/kg		**180**	<100	<100	**120**	<100
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.02**	**0.02**	**0.02**	**0.02**	**0.01**
EG005(ED093)T: Total Metals by ICP-AES									
Antimony	7440-36-0	5	mg/kg		<5	<5	<5	<5	<5
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	**0.1**
EK040T: Fluoride Total									
Fluoride	16984-48-8	40	mg/kg		<40	<40	<40	<40	<40

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	SW-S1-N	SW-S2-N	SW-S3-N	SW-S4-N	DRILL-S1-S
			Sampling date / time	30-Apr-2024 08:50	30-Apr-2024 09:10	30-Apr-2024 09:20	30-Apr-2024 09:04	30-Apr-2024 08:15
Compound	CAS Number	LOR	Unit	EB2414326-006	EB2414326-007	EB2414326-008	EB2414326-009	EB2414326-010
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-820**	**-897**	**-578**	**-746**	**-1030**
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**11.1**	**10.9**	**10.5**	**10.8**	**11.2**
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**821**	**897**	**578**	**746**	**1030**
ANC as CaCO3	----	0.1	% CaCO3	**83.7**	**91.5**	**59.0**	**76.1**	**105**
Fizz Rating	----	0	Fizz Unit	**5**	**5**	**5**	**5**	**5**
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**9.2**	**9.1**	**8.7**	**8.9**	**9.6**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	**0.008**	<0.005	**0.006**	**0.008**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	**75.3**	**78.9**	**59.0**	**74.2**	**100**
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	**15000**	**15800**	**11800**	**14800**	**20000**
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	**24.1**	**25.2**	**18.9**	**23.8**	**32.0**
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	SW-S1-N	SW-S2-N	SW-S3-N	SW-S4-N	DRILL-S1-S
			Sampling date / time	30-Apr-2024 08:50	30-Apr-2024 09:10	30-Apr-2024 09:20	30-Apr-2024 09:04	30-Apr-2024 08:15
Compound	CAS Number	LOR	Unit	EB2414326-006	EB2414326-007	EB2414326-008	EB2414326-009	EB2414326-010
				Result	Result	Result	Result	Result
EA033-E: Acid Base Accounting - Continued								
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	<1	<1	<1
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	**3.1**	**3.5**	**6.7**	**3.7**	**0.7**
ED040: Sulfur as SO4 2-								
Sulfate as SO4 2-	14808-79-8	100	mg/kg	**110**	**100**	<100	<100	<100
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.02**	**0.01**	**0.01**	**0.01**	**0.02**
EG005(ED093)T: Total Metals by ICP-AES								
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	<5
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	**0.4**	<0.1	<0.1	<0.1	<0.1
EK040T: Fluoride Total								
Fluoride	16984-48-8	40	mg/kg	<40	<40	<40	<40	<40

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	DRILL-S2-N	DRILL-S3-M	NW-S1-W	NW-S2-W	NW-S3-S
			Sampling date / time	30-Apr-2024 08:15	30-Apr-2024 08:15	30-Apr-2024 09:50	30-Apr-2024 10:00	30-Apr-2024 10:10
Compound	CAS Number	LOR	Unit	EB2414326-011	EB2414326-012	EB2414326-013	EB2414326-014	EB2414326-015
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-1020**	**-1020**	**-1000**	**-986**	**-885**
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**9.5**	**11.0**	**11.5**	**11.4**	**11.4**
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**1020**	**1020**	**1000**	**986**	**886**
ANC as CaCO3	----	0.1	% CaCO3	**104**	**104**	**102**	**100**	**90.4**
Fizz Rating	----	0	Fizz Unit	**5**	**5**	**5**	**5**	**5**
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**9.6**	**9.6**	**9.6**	**9.6**	**9.3**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.036**	**0.074**	**0.008**	**0.005**	**0.012**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	**23**	**46**	<10	<10	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	**101**	**88.5**	**99.9**	**88.7**	**88.0**
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	**20100**	**17700**	**20000**	**17700**	**17600**
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	**32.3**	**28.4**	**32.0**	**28.4**	**28.2**
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	DRILL-S2-N	DRILL-S3-M	NW-S1-W	NW-S2-W	NW-S3-S
			Sampling date / time	30-Apr-2024 08:15	30-Apr-2024 08:15	30-Apr-2024 09:50	30-Apr-2024 10:00	30-Apr-2024 10:10
Compound	CAS Number	LOR	Unit	EB2414326-011	EB2414326-012	EB2414326-013	EB2414326-014	EB2414326-015
				Result	Result	Result	Result	Result
EA033-E: Acid Base Accounting - Continued								
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	**0.04**	**0.07**	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**23**	**46**	<10	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	**2**	**3**	<1	<1	<1
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	**0.5**	**0.5**	**2.7**	**4.1**	**1.5**
ED040: Sulfur as SO4 2-								
Sulfate as SO4 2-	14808-79-8	100	mg/kg	<100	<100	<100	**210**	<100
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.04**	**0.07**	**0.01**	**0.01**	**0.02**
EG005(ED093)T: Total Metals by ICP-AES								
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	<5
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	**0.1**
EK040T: Fluoride Total								
Fluoride	16984-48-8	40	mg/kg	<40	<40	**60**	<40	<40

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	NW-S4-S	NW-S5-E	NW-S6-E	NW-S7-E	NW-S8-TOP 1
			Sampling date / time	30-Apr-2024 10:20	30-Apr-2024 10:30	30-Apr-2024 10:40	30-Apr-2024 10:45	30-Apr-2024 10:55
Compound	CAS Number	LOR	Unit	EB2414326-016	EB2414326-017	EB2414326-018	EB2414326-019	EB2414326-020
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-1010**	**-515**	**-942**	**-1030**	**-173**
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**11.3**	**11.7**	**11.4**	**11.4**	**10.2**
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**1010**	**516**	**942**	**1030**	**173**
ANC as CaCO3	----	0.1	% CaCO3	**103**	**52.6**	**96.0**	**105**	**17.6**
Fizz Rating	----	0	Fizz Unit	**5**	**5**	**5**	**5**	**3**
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**9.6**	**9.1**	**9.6**	**9.6**	**8.2**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.008**	**0.016**	<0.005	**0.013**	<0.005
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	**99.8**	**48.5**	**88.1**	**101**	**14.0**
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	**19900**	**9690**	**17600**	**20200**	**2800**
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	**32.0**	**15.5**	**28.2**	**32.4**	**4.50**
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	NW-S4-S	NW-S5-E	NW-S6-E	NW-S7-E	NW-S8-TOP 1
				Sampling date / time	30-Apr-2024 10:20	30-Apr-2024 10:30	30-Apr-2024 10:40	30-Apr-2024 10:45	30-Apr-2024 10:55
Compound	CAS Number	LOR	Unit		EB2414326-016	EB2414326-017	EB2414326-018	EB2414326-019	EB2414326-020
					Result	Result	Result	Result	Result
EA033-E: Acid Base Accounting - Continued									
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		<10	<10	<10	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t		<1	<1	<1	<1	<1
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		**2.1**	**2.0**	**0.5**	**3.4**	**5.6**
ED040: Sulfur as SO4 2-									
Sulfate as SO4 2-	14808-79-8	100	mg/kg		<100	<100	<100	<100	<100
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.02**	**0.02**	**0.01**	**0.02**	<0.01
EG005(ED093)T: Total Metals by ICP-AES									
Antimony	7440-36-0	5	mg/kg		<5	<5	<5	<5	<5
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		**0.1**	**0.1**	<0.1	<0.1	<0.1
EK040T: Fluoride Total									
Fluoride	16984-48-8	40	mg/kg		<40	**110**	**190**	**60**	**240**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	NW-S9-TOP 2	NW-S10-TOP 3	NW-A	SW-F	----
			Sampling date / time	30-Apr-2024 11:10	30-Apr-2024 11:15	30-Apr-2024 11:25	30-Apr-2024 09:50	----
Compound	CAS Number	LOR	Unit	EB2414326-021	EB2414326-022	EB2414326-023	EB2414326-024	--------
				Result	Result	Result	Result	----
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-1000**	**-922**	**-995**	**-738**	**----**
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**11.2**	**11.5**	**11.6**	**11.2**	**----**
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	**----**
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	**----**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**1000**	**923**	**996**	**738**	**----**
ANC as CaCO3	----	0.1	% CaCO3	**102**	**94.1**	**102**	**75.2**	**----**
Fizz Rating	----	0	Fizz Unit	**5**	**5**	**5**	**5**	**----**
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**9.6**	**9.2**	**9.6**	**8.9**	**----**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	**----**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	**----**
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.006**	**0.006**	**0.008**	**0.006**	**----**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	**----**
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	**102**	**89.0**	**102**	**73.6**	**----**
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	**20400**	**17800**	**20300**	**14700**	**----**
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	**32.7**	**28.5**	**32.6**	**23.6**	**----**
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**----**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	**----**
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	**----**
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	**----**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	NW-S9-TOP 2	NW-S10-TOP 3	NW-A	SW-F	----
			Sampling date / time	30-Apr-2024 11:10	30-Apr-2024 11:15	30-Apr-2024 11:25	30-Apr-2024 09:50	----
Compound	CAS Number	LOR	Unit	EB2414326-021	EB2414326-022	EB2414326-023	EB2414326-024	--------
				Result	Result	Result	Result	----
EA033-E: Acid Base Accounting - Continued								
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	----
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	<1	<1	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	**2.4**	**4.0**	**0.6**	**8.8**	----
ED040: Sulfur as SO4 2-								
Sulfate as SO4 2-	14808-79-8	100	mg/kg	<100	<100	**140**	<100	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.01**	**0.02**	**0.02**	**0.01**	----
EG005(ED093)T: Total Metals by ICP-AES								
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	**0.1**	<0.1	<0.1	----
EK040T: Fluoride Total								
Fluoride	16984-48-8	40	mg/kg	<40	**50**	**90**	<40	----

Inter-Laboratory Testing

Analysis conducted by ALS Melbourne, NATA accreditation no. 825, site no. 13778 (Chemistry).

(SOIL) EK040T: Fluoride Total

QUALITY CONTROL REPORT

Work Order	: **EB2414326**	Page	: 1 of 7
Client	: **GRAYMONT (AUSTRALIA) PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: Vicki Robins	Contact	: Customer Services EB
Address	: MS 24 TARAGOOLA ROAD CALLIOPE 4680	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: ----	Telephone	: +61-7-3243 7222
Project	: Waste Dump Characteristics - Calliope	Date Samples Received	: 02-May-2024
Order number	: 833739	Date Analysis Commenced	: 03-May-2024
C-O-C number	: ----	Issue Date	: 16-May-2024
Sampler	: Vicki Robins		
Site	: ----		
Quote number	: BN/130/17 V4		
No. of samples received	: 24		
No. of samples analysed	: 24		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Soil Preparation, Stafford, QLD
Dilani Fernando	Laboratory Coordinator	Melbourne Inorganics, Springvale, VIC
Jarwis Nheu	Non-Metals Team Leader	Melbourne Inorganics, Springvale, VIC
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
EG005(ED093)T: Total Metals by ICP-AES (QC Lot: 5766984)									
EB2414326-001	SW-S1-S	EG005T: Antimony	7440-36-0	5	mg/kg	<5	<5	0.0	No Limit
EB2414326-011	DRILL-S2-N	EG005T: Antimony	7440-36-0	5	mg/kg	<5	<5	0.0	No Limit
EG005(ED093)T: Total Metals by ICP-AES (QC Lot: 5766986)									
EB2414326-021	NW-S9-TOP 2	EG005T: Antimony	7440-36-0	5	mg/kg	<5	<5	0.0	No Limit
EA011: Net Acid Generation (QC Lot: 5778773)									
EB2414326-001	SW-S1-S	EA011: NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	0.0	No Limit
		EA011: NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	0.0	No Limit
		EA011: pH (OX)	----	0.1	pH Unit	11.5	11.6	0.9	0% - 20%
EB2414326-011	DRILL-S2-N	EA011: NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	0.0	No Limit
		EA011: NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	0.0	No Limit
		EA011: pH (OX)	----	0.1	pH Unit	9.5	9.6	1.0	0% - 20%
EA011: Net Acid Generation (QC Lot: 5778776)									
EB2414326-021	NW-S9-TOP 2	EA011: NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	0.0	No Limit
		EA011: NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	0.0	No Limit
		EA011: pH (OX)	----	0.1	pH Unit	11.2	11.3	0.9	0% - 20%
EA013: Acid Neutralising Capacity (QC Lot: 5778772)									
EB2414326-001	SW-S1-S	EA013: ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	999	1000	0.7	0% - 20%
EB2414326-011	DRILL-S2-N	EA013: ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	1020	1020	0.1	0% - 20%
EA013: Acid Neutralising Capacity (QC Lot: 5778775)									

Sub-Matrix: **SOIL**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
EA013: Acid Neutralising Capacity (QC Lot: 5778775) - continued									
EB2414326-021	NW-S9-TOP 2	EA013: ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	1000	1010	0.7	0% - 20%
EA033-A: Actual Acidity (QC Lot: 5778774)									
EB2414326-001	SW-S1-S	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	9.4	9.4	0.0	0% - 20%
EB2414326-011	DRILL-S2-N	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	9.6	9.6	0.0	0% - 20%
EA033-A: Actual Acidity (QC Lot: 5778777)									
EB2414326-021	NW-S9-TOP 2	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	9.6	9.6	0.0	0% - 20%
EA033-B: Potential Acidity (QC Lot: 5778774)									
EB2414326-001	SW-S1-S	EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	0.009	0.012	21.6	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EB2414326-011	DRILL-S2-N	EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	0.036	0.035	4.0	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	23	22	0.0	No Limit
EA033-B: Potential Acidity (QC Lot: 5778777)									
EB2414326-021	NW-S9-TOP 2	EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	0.006	0.008	20.7	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EA033-C: Acid Neutralising Capacity (QC Lot: 5778774)									
EB2414326-001	SW-S1-S	EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	101	101	0.0	0% - 20%
		EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	32.4	32.4	0.0	0% - 20%
		EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	20200	20200	0.0	0% - 20%
EB2414326-011	DRILL-S2-N	EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	101	101	0.0	0% - 20%
		EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	32.3	32.3	0.0	0% - 20%
		EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	20100	20200	0.0	0% - 20%
EA033-C: Acid Neutralising Capacity (QC Lot: 5778777)									
EB2414326-021	NW-S9-TOP 2	EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	102	102	0.0	0% - 20%

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Acceptable RPD (%)*
EA033-C: Acid Neutralising Capacity (QC Lot: 5778777) - continued									
EB2414326-021	NW-S9-TOP 2	EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	32.7	32.6	0.0	0% - 20%
		EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	20400	20400	0.0	0% - 20%
EA055: Moisture Content (Dried @ 105-110°C) (QC Lot: 5766995)									
EB2414326-001	SW-S1-S	EA055: Moisture Content	----	0.1	%	4.5	4.6	2.4	0% - 20%
EB2414326-011	DRILL-S2-N	EA055: Moisture Content	----	0.1	%	0.5	0.5	0.0	No Limit
EA055: Moisture Content (Dried @ 105-110°C) (QC Lot: 5766996)									
EB2414326-021	NW-S9-TOP 2	EA055: Moisture Content	----	0.1	%	2.4	2.4	0.0	0% - 20%
ED040T : Total Sulfate by ICPAES (QC Lot: 5766993)									
EB2414326-001	SW-S1-S	ED040T: Sulfate as SO4 2-	14808-79-8	100	mg/kg	180	180	0.0	No Limit
EB2414326-010	DRILL-S1-S	ED040T: Sulfate as SO4 2-	14808-79-8	100	mg/kg	<100	<100	0.0	No Limit
ED040T : Total Sulfate by ICPAES (QC Lot: 5766994)									
EB2414326-021	NW-S9-TOP 2	ED040T: Sulfate as SO4 2-	14808-79-8	100	mg/kg	<100	<100	0.0	No Limit
ED042T: Total Sulfur by LECO (QC Lot: 5780614)									
EB2414326-001	SW-S1-S	ED042T: Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.02	0.0	No Limit
EB2414326-011	DRILL-S2-N	ED042T: Sulfur - Total as S (LECO)	----	0.01	%	0.04	0.05	0.0	No Limit
ED042T: Total Sulfur by LECO (QC Lot: 5780615)									
EB2414326-021	NW-S9-TOP 2	ED042T: Sulfur - Total as S (LECO)	----	0.01	%	0.01	0.01	0.0	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 5766985)									
EB2414326-001	SW-S1-S	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
EB2414326-011	DRILL-S2-N	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 5766987)									
EB2414326-021	NW-S9-TOP 2	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
EK040T: Fluoride Total (QC Lot: 5787232)									
EB2414326-001	SW-S1-S	EK040T: Fluoride	16984-48-8	40	mg/kg	<40	<40	0.0	No Limit
EB2414326-010	DRILL-S1-S	EK040T: Fluoride	16984-48-8	40	mg/kg	<40	50	0.0	No Limit
EK040T: Fluoride Total (QC Lot: 5787233)									
EB2414326-021	NW-S9-TOP 2	EK040T: Fluoride	16984-48-8	40	mg/kg	<40	<40	0.0	No Limit
EM2407337-011	Anonymous	EK040T: Fluoride	16984-48-8	40	mg/kg	50	50	0.0	No Limit

Method Blank (MB) and Laboratory Control Sample (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Acceptable Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 5766984)								
EG005T: Antimony	7440-36-0	5	mg/kg	<5	----	----	----	----
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 5766986)								
EG005T: Antimony	7440-36-0	5	mg/kg	<5	----	----	----	----
EA011: Net Acid Generation (QCLot: 5778773)								
EA011: NAG (pH 7.0)	----	----	kg H2SO4/t	----	22.83 kg H2SO4/t	94.2	70.0	130
EA011: Net Acid Generation (QCLot: 5778776)								
EA011: NAG (pH 7.0)	----	----	kg H2SO4/t	----	22.83 kg H2SO4/t	96.7	70.0	130
EA013: Acid Neutralising Capacity (QCLot: 5778772)								
EA013: ANC as H2SO4	----	----	kg H2SO4 equiv./t	----	196 kg H2SO4 equiv./t	104	82.0	120
EA013: Acid Neutralising Capacity (QCLot: 5778775)								
EA013: ANC as H2SO4	----	----	kg H2SO4 equiv./t	----	196 kg H2SO4 equiv./t	104	82.0	120
EA033-A: Actual Acidity (QCLot: 5778774)								
EA033: pH KCl (23A)	----	----	pH Unit	----	4.7 pH Unit	102	80.0	120
EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	23.5 mole H+ / t	116	80.0	120
EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033-A: Actual Acidity (QCLot: 5778777)								
EA033: pH KCl (23A)	----	----	pH Unit	----	4.7 pH Unit	103	80.0	120
EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	23.5 mole H+ / t	118	80.0	120
EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033-B: Potential Acidity (QCLot: 5778774)								
EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	0.246 % S	88.0	77.0	121
EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	----	----	----	----
EA033-B: Potential Acidity (QCLot: 5778777)								
EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	0.246 % S	91.8	77.0	121
EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	----	----	----	----
EA033-C: Acid Neutralising Capacity (QCLot: 5778774)								
EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	<0.01	10 % CaCO3	105	91.0	112
EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	<10	----	----	----	----
EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	<0.01	----	----	----	----
EA033-C: Acid Neutralising Capacity (QCLot: 5778777)								

Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Acceptable Limits (%): Low	Acceptable Limits (%): High
EA033-C: Acid Neutralising Capacity (QCLot: 5778777) - continued								
EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	<0.01	10 % CaCO3	108	91.0	112
EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	<10	----	----	----	----
EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	<0.01	----	----	----	----
ED040T : Total Sulfate by ICPAES (QCLot: 5766993)								
ED040T: Sulfate as SO4 2-	14808-79-8	100	mg/kg	<100	577.72262 mg/kg	88.5	79.0	121
ED040T : Total Sulfate by ICPAES (QCLot: 5766994)								
ED040T: Sulfate as SO4 2-	14808-79-8	100	mg/kg	<100	577.72262 mg/kg	85.0	79.0	121
ED042T: Total Sulfur by LECO (QCLot: 5780614)								
ED042T: Sulfur - Total as S (LECO)	----	0.01	%	<0.01	0.51 %	99.9	70.0	130
ED042T: Total Sulfur by LECO (QCLot: 5780615)								
ED042T: Sulfur - Total as S (LECO)	----	0.01	%	<0.01	0.51 %	102	70.0	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 5766985)								
EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	0.09199 mg/kg	111	70.0	125
EG035T: Total Recoverable Mercury by FIMS (QCLot: 5766987)								
EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	0.09199 mg/kg	112	70.0	125
EK040T: Fluoride Total (QCLot: 5787232)								
EK040T: Fluoride	16984-48-8	40	mg/kg	<40	334 mg/kg	97.0	93.1	107
EK040T: Fluoride Total (QCLot: 5787233)								
EK040T: Fluoride	16984-48-8	40	mg/kg	<40	334 mg/kg	97.0	93.1	107

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **SOIL**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%): MS	Acceptable Limits (%): Low	Acceptable Limits (%): High
EG035T: Total Recoverable Mercury by FIMS (QCLot: 5766985)							
EB2414326-002	SW-S2-S	EG035T: Mercury	7439-97-6	0.5 mg/kg	88.9	70.0	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 5766987)							
EB2414326-022	NW-S10-TOP 3	EG035T: Mercury	7439-97-6	0.5 mg/kg	93.9	70.0	130
EK040T: Fluoride Total (QCLot: 5787232)							
EB2414326-002	SW-S2-S	EK040T: Fluoride	16984-48-8	400 mg/kg	# 67.0	70.0	130
EK040T: Fluoride Total (QCLot: 5787233)							
EB2414326-022	NW-S10-TOP 3	EK040T: Fluoride	16984-48-8	400 mg/kg	70.6	70.0	130

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EB2414326**	Page	: 1 of 10
Client	: **GRAYMONT (AUSTRALIA) PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: Vicki Robins	Telephone	: +61-7-3243 7222
Project	: Waste Dump Characteristics - Calliope	Date Samples Received	: 02-May-2024
Site	: ----	Issue Date	: 16-May-2024
Sampler	: Vicki Robins	No. of samples received	: 24
Order number	: 833739	No. of samples analysed	: 24

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **SOIL**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
EK040T: Fluoride Total	EB2414326--002	SW-S2-S	**Fluoride**	16984-48-8	67.0 %	70.0-130%	**Recovery less than lower data quality objective**

Outliers : Analysis Holding Time Compliance

Matrix: **SOIL**

Method / Container / Client Sample ID(s)		Extraction / Preparation: Date extracted	Due for extraction	Days overdue	Analysis: Date analysed	Due for analysis	Days overdue
ED040: Sulfur as SO4 2-							
Soil Glass Jar - Unpreserved							
SW-S1-S,	SW-S2-S,	09-May-2024	07-May-2024	**2**	----	----	----
SW-S3-S,	SW-S4-S,						
SW-S5-S,	SW-S1-N,						
SW-S2-N,	SW-S3-N,						
SW-S4-N,	DRILL-S1-S,						
DRILL-S2-N,	DRILL-S3-M,						
NW-S1-W,	NW-S2-W,						
NW-S3-S,	NW-S4-S,						
NW-S5-E,	NW-S6-E,						
NW-S7-E,	NW-S8-TOP 1,						
NW-S9-TOP 2,	NW-S10-TOP 3,						
NW-A,	SW-F						

Outliers : Frequency of Quality Control Samples

Matrix: **SOIL**

Quality Control Sample Type / Analytical Methods	Method	Count: QC	Count: Regular	Rate (%): Actual	Rate (%): Expected	Quality Control Specification
Laboratory Control Samples (LCS)						
Total Metals by ICP-AES	EG005T	0	24	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)						
Total Metals by ICP-AES	EG005T	0	24	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA011: Net Acid Generation								
Pulp Bag (EA011)								
SW-S1-S,	SW-S2-S,	**30-Apr-2024**	**10-May-2024**	30-Apr-2025	✓	**10-May-2024**	06-Nov-2024	✓
SW-S3-S,	SW-S4-S,							
SW-S5-S,	SW-S1-N,							
SW-S2-N,	SW-S3-N,							
SW-S4-N,	DRILL-S1-S,							
DRILL-S2-N,	DRILL-S3-M,							
NW-S1-W,	NW-S2-W,							
NW-S3-S,	NW-S4-S,							
NW-S5-E,	NW-S6-E,							
NW-S7-E,	NW-S8-TOP 1,							
NW-S9-TOP 2,	NW-S10-TOP 3,							
NW-A,	SW-F							
EA013: Acid Neutralising Capacity								
Pulp Bag (EA013)								
SW-S1-S,	SW-S2-S,	**30-Apr-2024**	**10-May-2024**	30-Apr-2025	✓	**10-May-2024**	06-Nov-2024	✓
SW-S3-S,	SW-S4-S,							
SW-S5-S,	SW-S1-N,							
SW-S2-N,	SW-S3-N,							
SW-S4-N,	DRILL-S1-S,							
DRILL-S2-N,	DRILL-S3-M,							
NW-S1-W,	NW-S2-W,							
NW-S3-S,	NW-S4-S,							
NW-S5-E,	NW-S6-E,							
NW-S7-E,	NW-S8-TOP 1,							
NW-S9-TOP 2,	NW-S10-TOP 3,							
NW-A,	SW-F							
EA033-A: Actual Acidity								
Pulp Bag (EA033)								
SW-S1-S,	SW-S2-S,	**30-Apr-2024**	**10-May-2024**	30-Apr-2025	✓	**10-May-2024**	08-Aug-2024	✓
SW-S3-S,	SW-S4-S,							
SW-S5-S,	SW-S1-N,							
SW-S2-N,	SW-S3-N,							
SW-S4-N,	DRILL-S1-S,							
DRILL-S2-N,	DRILL-S3-M,							
NW-S1-W,	NW-S2-W,							
NW-S3-S,	NW-S4-S,							
NW-S5-E,	NW-S6-E,							
NW-S7-E,	NW-S8-TOP 1,							
NW-S9-TOP 2,	NW-S10-TOP 3,							
NW-A,	SW-F							

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA033-B: Potential Acidity								
Pulp Bag (EA033)								
SW-S1-S,	SW-S2-S,	**30-Apr-2024**	**10-May-2024**	30-Apr-2025	✓	**10-May-2024**	08-Aug-2024	✓
SW-S3-S,	SW-S4-S,							
SW-S5-S,	SW-S1-N,							
SW-S2-N,	SW-S3-N,							
SW-S4-N,	DRILL-S1-S,							
DRILL-S2-N,	DRILL-S3-M,							
NW-S1-W,	NW-S2-W,							
NW-S3-S,	NW-S4-S,							
NW-S5-E,	NW-S6-E,							
NW-S7-E,	NW-S8-TOP 1,							
NW-S9-TOP 2,	NW-S10-TOP 3,							
NW-A,	SW-F							
EA033-C: Acid Neutralising Capacity								
Pulp Bag (EA033)								
SW-S1-S,	SW-S2-S,	**30-Apr-2024**	**10-May-2024**	30-Apr-2025	✓	**10-May-2024**	08-Aug-2024	✓
SW-S3-S,	SW-S4-S,							
SW-S5-S,	SW-S1-N,							
SW-S2-N,	SW-S3-N,							
SW-S4-N,	DRILL-S1-S,							
DRILL-S2-N,	DRILL-S3-M,							
NW-S1-W,	NW-S2-W,							
NW-S3-S,	NW-S4-S,							
NW-S5-E,	NW-S6-E,							
NW-S7-E,	NW-S8-TOP 1,							
NW-S9-TOP 2,	NW-S10-TOP 3,							
NW-A,	SW-F							
EA033-D: Retained Acidity								
Pulp Bag (EA033)								
SW-S1-S,	SW-S2-S,	**30-Apr-2024**	**10-May-2024**	30-Apr-2025	✓	**10-May-2024**	08-Aug-2024	✓
SW-S3-S,	SW-S4-S,							
SW-S5-S,	SW-S1-N,							
SW-S2-N,	SW-S3-N,							
SW-S4-N,	DRILL-S1-S,							
DRILL-S2-N,	DRILL-S3-M,							
NW-S1-W,	NW-S2-W,							
NW-S3-S,	NW-S4-S,							
NW-S5-E,	NW-S6-E,							
NW-S7-E,	NW-S8-TOP 1,							
NW-S9-TOP 2,	NW-S10-TOP 3,							
NW-A,	SW-F							

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA033-E: Acid Base Accounting								
Pulp Bag (EA033)								
SW-S1-S,	SW-S2-S,	**30-Apr-2024**	**10-May-2024**	30-Apr-2025	✓	**10-May-2024**	08-Aug-2024	✓
SW-S3-S,	SW-S4-S,							
SW-S5-S,	SW-S1-N,							
SW-S2-N,	SW-S3-N,							
SW-S4-N,	DRILL-S1-S,							
DRILL-S2-N,	DRILL-S3-M,							
NW-S1-W,	NW-S2-W,							
NW-S3-S,	NW-S4-S,							
NW-S5-E,	NW-S6-E,							
NW-S7-E,	NW-S8-TOP 1,							
NW-S9-TOP 2,	NW-S10-TOP 3,							
NW-A,	SW-F							
EA055: Moisture Content (Dried @ 105-110°C)								
Soil Glass Jar - Unpreserved (EA055)								
SW-S1-S,	SW-S2-S,	**30-Apr-2024**	**----**	----	----	**03-May-2024**	14-May-2024	✓
SW-S3-S,	SW-S4-S,							
SW-S5-S,	SW-S1-N,							
SW-S2-N,	SW-S3-N,							
SW-S4-N,	DRILL-S1-S,							
DRILL-S2-N,	DRILL-S3-M,							
NW-S1-W,	NW-S2-W,							
NW-S3-S,	NW-S4-S,							
NW-S5-E,	NW-S6-E,							
NW-S7-E,	NW-S8-TOP 1,							
NW-S9-TOP 2,	NW-S10-TOP 3,							
NW-A,	SW-F							
ED040: Sulfur as SO4 2-								
Soil Glass Jar - Unpreserved (ED040T)								
SW-S1-S,	SW-S2-S,	**30-Apr-2024**	**09-May-2024**	07-May-2024	×	**15-May-2024**	06-Jun-2024	✓
SW-S3-S,	SW-S4-S,							
SW-S5-S,	SW-S1-N,							
SW-S2-N,	SW-S3-N,							
SW-S4-N,	DRILL-S1-S,							
DRILL-S2-N,	DRILL-S3-M,							
NW-S1-W,	NW-S2-W,							
NW-S3-S,	NW-S4-S,							
NW-S5-E,	NW-S6-E,							
NW-S7-E,	NW-S8-TOP 1,							
NW-S9-TOP 2,	NW-S10-TOP 3,							
NW-A,	SW-F							

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED042T: Total Sulfur by LECO								
Pulp Bag (ED042T)								
SW-S1-S,	SW-S2-S,	**30-Apr-2024**	**10-May-2024**	27-Oct-2024	✓	**10-May-2024**	27-Oct-2024	✓
SW-S3-S,	SW-S4-S,							
SW-S5-S,	SW-S1-N,							
SW-S2-N,	SW-S3-N,							
SW-S4-N,	DRILL-S1-S,							
DRILL-S2-N,	DRILL-S3-M,							
NW-S1-W,	NW-S2-W,							
NW-S3-S,	NW-S4-S,							
NW-S5-E,	NW-S6-E,							
NW-S7-E,	NW-S8-TOP 1,							
NW-S9-TOP 2,	NW-S10-TOP 3,							
NW-A,	SW-F							
EG005(ED093)T: Total Metals by ICP-AES								
Soil Glass Jar - Unpreserved (EG005T)								
SW-S1-S,	SW-S2-S,	**30-Apr-2024**	**09-May-2024**	27-Oct-2024	✓	**15-May-2024**	27-Oct-2024	✓
SW-S3-S,	SW-S4-S,							
SW-S5-S,	SW-S1-N,							
SW-S2-N,	SW-S3-N,							
SW-S4-N,	DRILL-S1-S,							
DRILL-S2-N,	DRILL-S3-M,							
NW-S1-W,	NW-S2-W,							
NW-S3-S,	NW-S4-S,							
NW-S5-E,	NW-S6-E,							
NW-S7-E,	NW-S8-TOP 1,							
NW-S9-TOP 2,	NW-S10-TOP 3,							
NW-A,	SW-F							
EG035T: Total Recoverable Mercury by FIMS								
Soil Glass Jar - Unpreserved (EG035T)								
SW-S1-S,	SW-S2-S,	**30-Apr-2024**	**09-May-2024**	28-May-2024	✓	**15-May-2024**	28-May-2024	✓
SW-S3-S,	SW-S4-S,							
SW-S5-S,	SW-S1-N,							
SW-S2-N,	SW-S3-N,							
SW-S4-N,	DRILL-S1-S,							
DRILL-S2-N,	DRILL-S3-M,							
NW-S1-W,	NW-S2-W,							
NW-S3-S,	NW-S4-S,							
NW-S5-E,	NW-S6-E,							
NW-S7-E,	NW-S8-TOP 1,							
NW-S9-TOP 2,	NW-S10-TOP 3,							
NW-A,	SW-F							

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK040T: Fluoride Total								
Snap Lock Bag (EK040T)								
SW-S1-S,	SW-S2-S,	**30-Apr-2024**	**14-May-2024**	28-May-2024	✓	**15-May-2024**	28-May-2024	✓
SW-S3-S,	SW-S4-S,							
SW-S5-S,	SW-S1-N,							
SW-S2-N,	SW-S3-N,							
SW-S4-N,	DRILL-S1-S,							
DRILL-S2-N,	DRILL-S3-M,							
NW-S1-W,	NW-S2-W,							
NW-S3-S,	NW-S4-S,							
NW-S5-E,	NW-S6-E,							
NW-S7-E,	NW-S8-TOP 1,							
NW-S9-TOP 2,	NW-S10-TOP 3,							
NW-A,	SW-F							

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Acid Neutralising Capacity (ANC)	EA013	3	24	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chromium Suite for Acid Sulphate Soils	EA033	3	24	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Moisture Content	EA055	3	24	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Net Acid Generation	EA011	3	24	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate as SO4 2- Total	ED040T	3	24	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfur - Total as S (LECO)	ED042T	3	24	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Fluoride	EK040T	4	29	**13.79**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	3	24	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	3	24	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Acid Neutralising Capacity (ANC)	EA013	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chromium Suite for Acid Sulphate Soils	EA033	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Net Acid Generation	EA011	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate as SO4 2- Total	ED040T	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfur - Total as S (LECO)	ED042T	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Fluoride	EK040T	2	29	**6.90**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	0	24	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chromium Suite for Acid Sulphate Soils	EA033	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate as SO4 2- Total	ED040T	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfur - Total as S (LECO)	ED042T	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Fluoride	EK040T	2	29	**6.90**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Total Fluoride	EK040T	2	29	**6.90**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	0	24	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Net Acid Production Potential	EA009	SOIL	In house: Referenced to Coastech Research (Canada)(Mod.). NAPP = Acid Production Potential (APP or MAP-Maximum Acid Potential) minus Neutralising Capacity (ANC). NAPP may be +ve, zero or -ve.
Net Acid Generation	EA011	SOIL	In house: Referenced to Miller (1998) Titremetric procedure determines net acidity in a soil following peroxide oxidation. Titrations to both pH 4.5 and pH 7 are reported.
Acid Neutralising Capacity (ANC)	EA013	SOIL	In house: Referenced to USEPA 600/2-78-054, I. Miller (2000). A fizz test is done to semiquanititatively estimate the likely reactivity. The soil is then reacted with an known excess quanitity of an appropriate acid. Titration determines the acid remaining, and the ANC can be calculated from comparison with a blank titration.
Chromium Suite for Acid Sulphate Soils	EA033	SOIL	In house: Referenced to Ahern et al 2004. This method covers the determination of Chromium Reducible Sulfur (SCR); pHKCl; titratable actual acidity (TAA); acid neutralising capacity by back titration (ANC); and net acid soluble sulfur (SNAS) which incorporates peroxide sulfur. It applies to soils and sediments (including sands) derived from coastal regions. Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5.
Moisture Content	EA055	SOIL	In house: A gravimetric procedure based on weight loss over a 12 hour drying period at 105-110 degrees C. This method is compliant with NEPM Schedule B(3).
Sulfate as SO4 2- Total	ED040T	SOIL	In house: Total Sulfate is determined off a HCl digestion by ICPAES as S , and reported as SO4
Sulfur - Total as S (LECO)	ED042T	SOIL	In house: Dried and pulverised sample is combusted in a high temperature furnace in the presence of strong oxidants / catalysts. The evolved S (as SO2) is measured by infra-red detector
Total Metals by ICP-AES	EG005T	SOIL	In house: Referenced to APHA 3120; USEPA SW 846 - 6010. Metals are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM Schedule B(3)
Total Mercury by FIMS	EG035T	SOIL	In house: Referenced to APHA 3112 Hg - B (Flow-injection (SnCl2) (Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. Mercury in solids are determined following an appropriate acid digestion. Ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM Schedule B(3)
Total Fluoride	EK040T	SOIL	(In-house) Total fluoride is determined by ion specific electrode (ISE) in a solution obtained after a Sodium Carbonate / Potassium Carbonate fusion dissolution.

Preparation Methods	Method	Matrix	Method Descriptions
Total Fluoride	EK040T-PR	SOIL	In house: Samples are fused with Sodium Carbonate / Potassium Carbonate flux.
Drying at 85 degrees, bagging and labelling (ASS)	EN020PR	SOIL	In house
HCl Digest	EN24	SOIL	1g of soil is digested in 30 ml of 30% HCl and the resultant digest bulked and filtered for analysis by ICP.

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*
Hot Block Digest for metals in soils sediments and sludges	EN69	SOIL	In house: Referenced to USEPA 200.2. Hot Block Acid Digestion 1.0g of sample is heated with Nitric and Hydrochloric acids, then cooled. Peroxide is added and samples heated and cooled again before being filtered and bulked to volume for analysis. Digest is appropriate for determination of selected metals in sludge, sediments, and soils. This method is compliant with NEPM Schedule B(3).
Dry and Pulverise (up to 100g)	GEO30	SOIL	#

APPENDIX B PETROGRAPHIC ANALYSIS

Groundwork Plus Resources Environment Planning Laboratories
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ABN 13 609 422 791

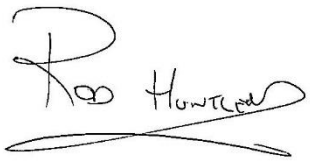
Petrographic Inspection Report

Prepared for:	Superior Quarry Testing
Purchase Order:	Not Provided
Material Source:	Graymont (Taragoola) Quarry, QLD
Sample Type:	Type 2.1 Roadbase
Sample Number:	SN 5459
Date Sampled:	Not Provided
Date of Inspection:	17/01/2022
Report Issued:	18/01/2022
Project/ File Ref.:	P2021_213_01

Author: 

Mathew Beddard (BSc)

Petrologist
Groundwork Plus

Reviewer: 

Rod Huntley (BSc, M.App.Sc, M.Eng)
Principal Resource Consultant
Groundwork Plus

Enquiries regarding the content of this report should be directed to Groundwork Plus 07 3871 0411*. Samples are disposed of after 3 months from the date of report. Thin sections will remain on site indefinitely. The analysis is based on a limited number of thin sections and sample provided by client, further investigation may be required. Interpretations are specific to the sample examined only.*

Executive Summary

Classification: Limestone

For Engineering Purposes AS 2758.1: Roadbase derived from derived from carbonate sedimentary rock

Key Material Risk: Negligible risk

Table 1 – Summary of Sample's Compositional Characteristics

Compositional Features	%	Comments
Strong Phases	93	Calcite; *trace:* opaques
Weak Phases	7	Goethite
Clays	0	None observed
Micas	0	None observed
Sulphides	0	None observed
Carbonates	93	Calcite
Textural Features	**Yes/ No**	
Fracturing/Veins	Yes	Abundant diagenetic sparry calcite veins. Minor goethite veins. No fractures observed
Voids	No	None observed
Free Silica	**%**	
Unstrained quartz	0	None observed
Optically strained quartz	0	None observed
Microcrystalline quartz	0	None observed
Siliceous volcanic glass	0	None observed
Opaline/chalcedonic quartz	0	None observed
Total	0	

Table 2 – Risk Rating for Specific Applications and Source Rock Quality

Specific Application	Low	Mod	High	Comments
Coarse Aggregate in Concrete (MRTS70)	✓			Texturally isolated weak/secondary phases unlikely to cause deleterious reactions or significantly increase water demand in concrete
Manufactured Sand	✓			Considered suitable after processing to remove goethitic fines
Aggregate Unbound Pavements (MRTS05)	✓			Suitable hardness, strength, and durability (after processing to remove goethitic fines)
Cover Aggregate (MRTS22)	✓			Suitable hardness, strength, and durability (after processing to remove goethitic fines)
Graded Asphalt Aggregate (MRTS101)	✓			Suitable hardness, strength, and durability (after processing to remove goethitic fines)
Gabion/Revetment	✓			Mechanically suitable
Material Characteristics	**Low**	**Mod**	**High**	**Comments**
Hardness	✓			Hard
Strength	✓			Strong
Durability	✓			Durable
ACR in concrete	✓			Innocuous. No dolomite detected.
ASR in concrete	✓			Innocuous. No reactive silica detected.

Introduction

This report provides the results of a general petrographic assessment of a roadbase sample, which was submitted to the Groundwork Plus petrographic laboratory, and describes the method and standards used to assess the sample. The supplied sample was sampled by the client and sent to the Groundwork Plus petrographic facility. The thin section was prepared and analysed by Groundwork Plus with instructions from the client to conduct petrographic testing to ASTM C295 and recommend further testing if significant deleterious characteristics are identified pursuant to Clause 16.3 of this standard. The provided modal mineral percentages relate to the supplied sample which is understood to be representative of material on site. Assessment regarding the Alkali-Silica Reactivity (ASR) potential of the aggregate has been advised by SA HB 79-2015. Communication of findings are advised by AS 1726-2017 Geotechnical Site Investigations.

Methodology

The petrographic assessment of the slide is carried out using a Nikon polarising microscope equipped with a digital camera at the Groundwork Plus petrographic laboratory. Photographs of the hand specimen and thin section photomicrographs showing grain sizes and any particular aspects of the minerals are included as part of the report (**Plates 1** to **6**). Modal analysis is conducted on the sample using a MA945/10 Mechanical Point Counter on 600 points (**Table 3 – Modal Analysis of Minerals**).

The petrology assessment is based on:

- ASTM C 295 – 2019 Standard Guide for Petrographic Examination of Aggregates for Concrete.
- AS 2758.1 – 2014 Aggregates and Rock for Engineering Purposes Part 1: Concrete Aggregates (Appendix B).
- AS 2758.2 – 2014 Aggregates and Rock for Engineering Purposes Part 2: Aggregate for sprayed bituminous surfacing.
- AS 2758.4 – 2014 Aggregates and Rock for Engineering Purposes Part 4: Aggregate for gabion baskets and wire mattresses.
- AS 2758.5 – 2014 Aggregates and Rock for Engineering Purposes Part 5: Asphalt Aggregates.
- AS 2758.6 – 2014 Aggregates and Rock for Engineering Purposes Part 6: Guidelines for the specification of Armourstone.
- AS 1141.26 – 2019 Standard Guide for the Method for Sampling and Testing Aggregates – Secondary Minerals Content in Igneous Rocks.
- The accepted definition of free silica is set out in the Queensland Department of Transport and Main Roads Test Method Q188, and tested pursuant to guidelines set in Standards Australia HB 79-2015 Alkali-Aggregate Reaction - Guidelines on Minimising the Risk of Damage to Concrete Structure in Australia - Cement and Concrete Association of Australia and Standards Australia.

Hand Specimen Description

In hand specimen, the roadbase sample is identified as being derived from a **limestone**, a carbonate sedimentary rock.

The sample consists of variably sized, poorly sorted aggregate particles and abundant fines. Particles measure up to 20mm in size. Particles are angular to very angular, with variable sphericity. Prior to washing, the sample contains abundant goethitic fines and dust, giving it an overall light orangish-brown colour. Goethite dust coats most particles as well as forming liberated binder. Washing removes most dust to produce a turbid orangish-brown water. The washed particles show variable colour, with most being light to dark grey. Acid testing indicates the sample is composed of calcite. The shade of grey is dependent upon the texture of calcite that makes up the particle, with micrite being darker grey and sparry calcite being lighter. A minor abundance of particles show extensive internal staining of goethite, giving them an orange to reddish-brown colour.

The sample particles are regarded as strong and hard, with competent faces. No fractures or voids are observed. No sulphides are observed and the sample is not appreciably magnetic.

Plate 1: Photograph of the sample as provided, showing the poorly sorted, angular roadbase particles coated in abundant, light orangish-brown fines.

Plate 2: Photograph of sample when wetted, which removes the goethitic fines leaving the variably coloured limestone particles.

Thin Section Description

In thin section, the sample is conformed to derive from a limestone. The limestone shows textures consistent with classification as a mudstone with minor wackestone regions. Diagenetic alteration has seen replacement of micritic calcite with sparry calcite veins and bands. A mode base on a count of 600 widely spaced points is shown in **Table 3 - Modal Analysis of Minerals**. Robust minerals make up 93% of the rock and include calcite (split into micrite and sparry varieties) and trace opaques. Goethite is the only observed weak phase and accounts for 7% of the sample.

Table 3 - Modal Analysis of Minerals

Primary Minerals	Mode (%)	Comments
Calcite – micritic	41	Calcite showing massive, micritic texture. Also includes rare bioclastic/wackestone texture
Calcite – sparry	52	Calcite crystals showing sparry texture including twinning. Occurs as replacement of micrite.
Opaques	Trace	Trace, 0.05mm sized, rounded, opaque, magnetite crystals
Secondary Minerals		
Goethite	7	Abundant in the fines and dust as orange-coloured accretions. Minor staining within some particles. Minor veins and veinlets observed
Total	**100**	

Calcite forms most of the sample at 93% of the mineral count. Calcite is observed showing micritic texture (41% of the sample) and sparry texture (52%). The micritic calcite is regarded as the primary texture prior to replacement by sparry crystals during diagenesis. The micritic regions are typical of carbonate mudstones, with expansive regions of microcrystalline, massive calcite. In some areas, rare bioclasts are observed giving a more wackestone texture. Bioclasts include gastropods and bivalves. The distribution of sparry calcite is variable, with veinlets, veins, and large bands and patches observed. Some areas contain abundant crosscutting veins and veinlets; others are dominated by wide bands of sparry crystals. The remaining robust phase observed is trace opaque magnetite, which is disseminated throughout the sample as small, 0.05mm sized, rounded crystals.

The finer material in the sample is dominated by goethite (7%). Goethitic accretions coat most particles, with a minor abundance of particles having interior ferruginous staining. The goethitic fines are easily removed by washing the sample. Minor veins and veinlets of goethite are also observed crosscutting the calcite and indicating later weathering of the rock.

Overall, the sample is considered hard, strong, and durable, and considered suitable for use as a roadbase. The goethitic fines are expected to perform well as binder for the roadbase. After processing to remove fines, the sample is regarded as suitable for use as coarse aggregate in concrete, unbound pavements, cover aggregate, graded asphalt, and gabion/revetment. Extensive crushing is expected to produce a quality carbonate manufactured sand.

Free Silica Content

After conducting a modal analysis using the MA945-10 mechanical point counter on 600 points, the total free silica content was found to be 0%. The sample was found to contain **no reactive silica.**

According to Standards Australia HB 79-2015 and Department of Transport and Main Roads test method Q188, the provided aggregate is assessed as **innocuous in regard to ASR** in concrete.

Asbestiform Minerals

Asbestos can be defined mineralogically and by crystal habit. For the purposes of health screening asbestiform habit is relevant, which is defined as being hair-like (filiform) and flexible with a high aspect ratio. Based on the thin section constructed from the material supplied, the sample contains **no observable asbestiform minerals**.

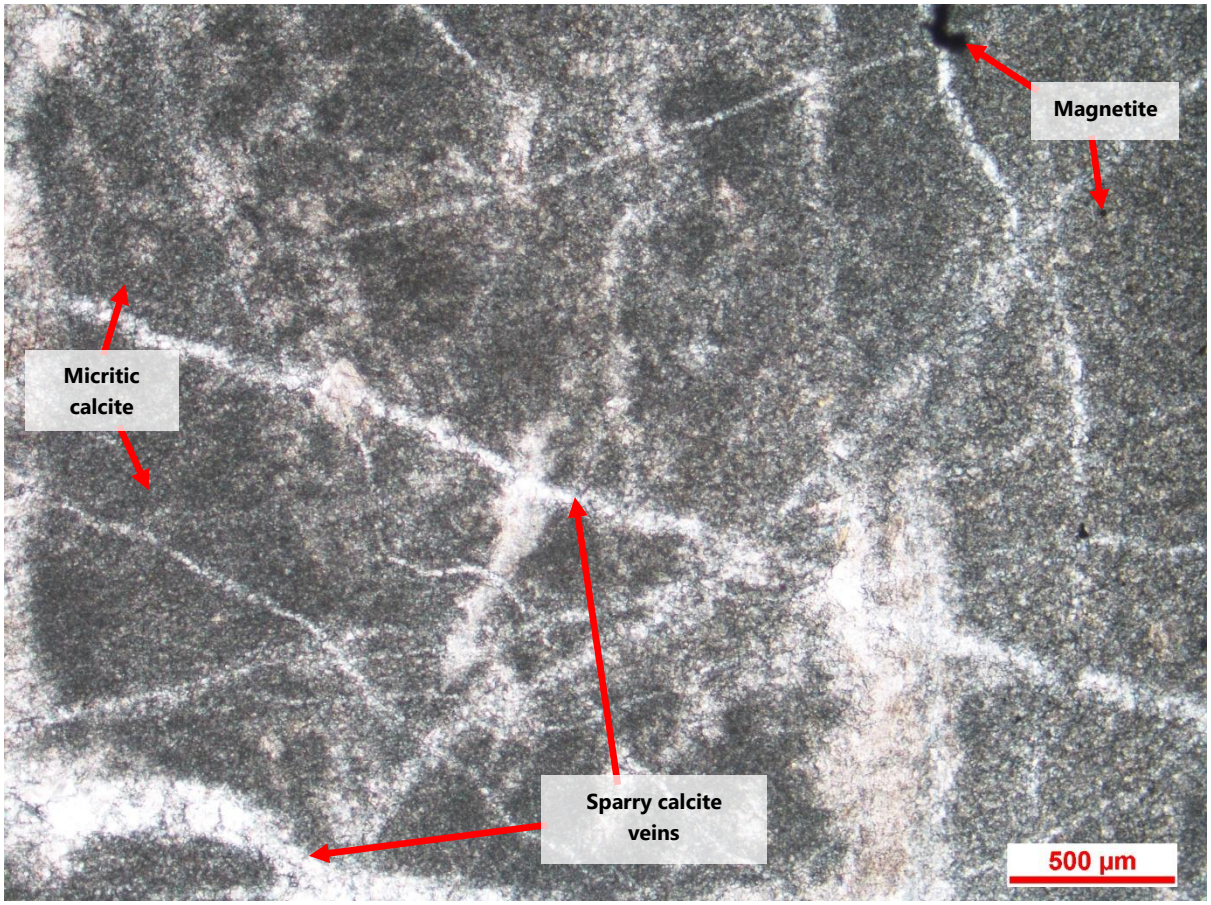


Plate 3: Microphotograph of the sample, showing abundant sparry calcite veins crosscutting the micritic calcite. Image shown in plane polarised light. Scale = 500µm x 40 magnification. F.O.V. 5.2mm.

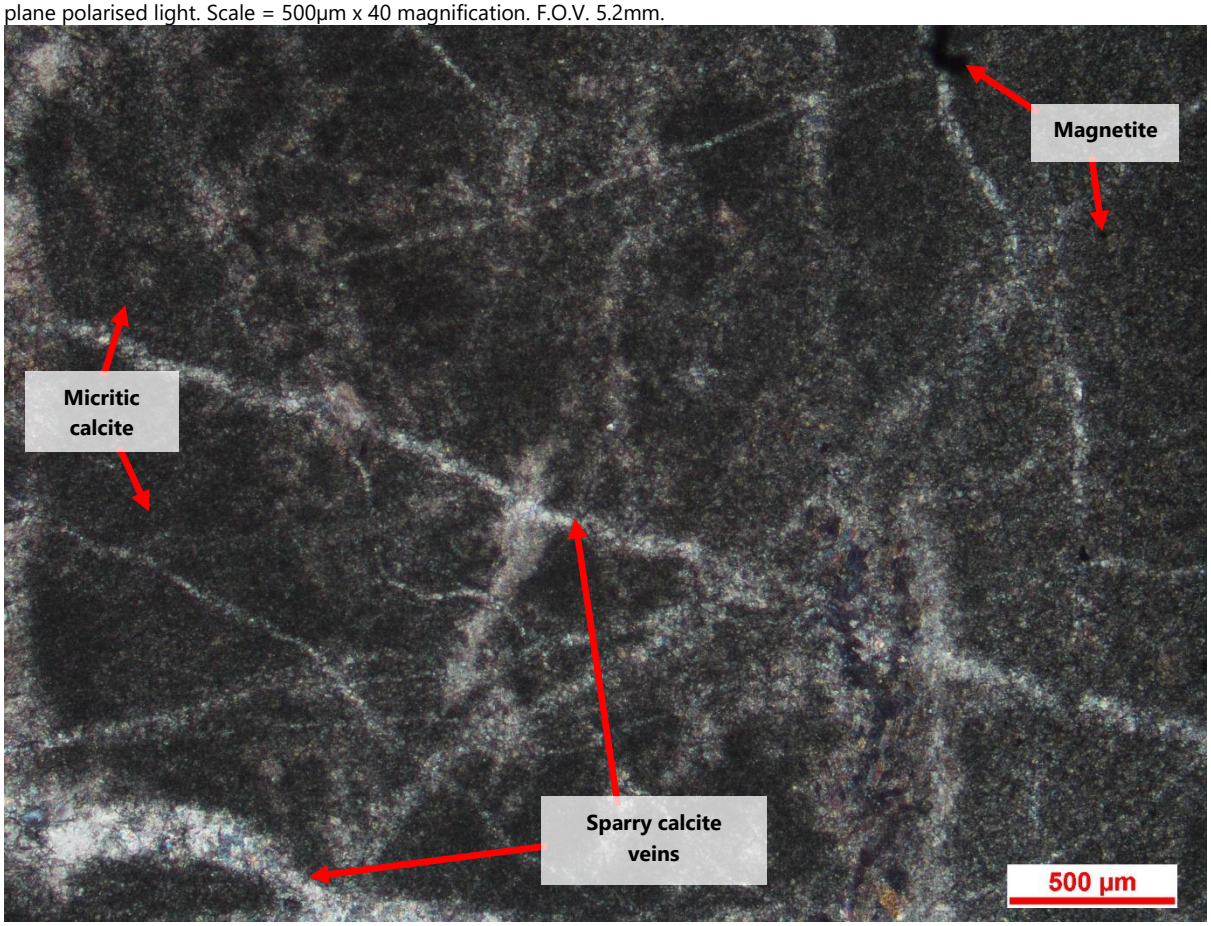


Plate 4: The same image from **Plate 3** under crossed polarised light. Scale = 500µm x 40 magnification. F.O.V. 5.2mm.

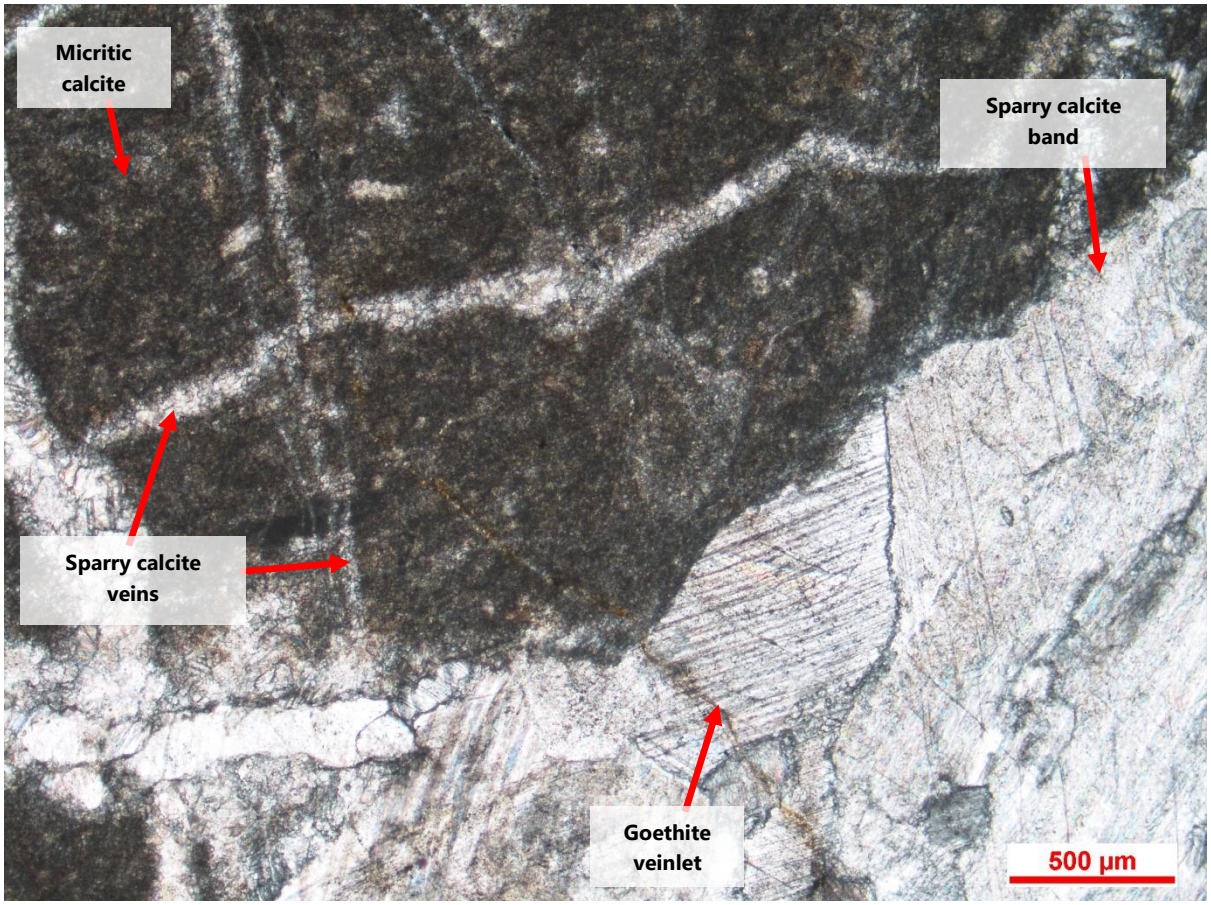


Plate 5: Microphotograph of the sample, showing sparry veins and a large sparry band crosscutting the micritic calcite. Image shown in plane polarised light. Scale = 500µm x 40 magnification. F.O.V. 5.2mm.

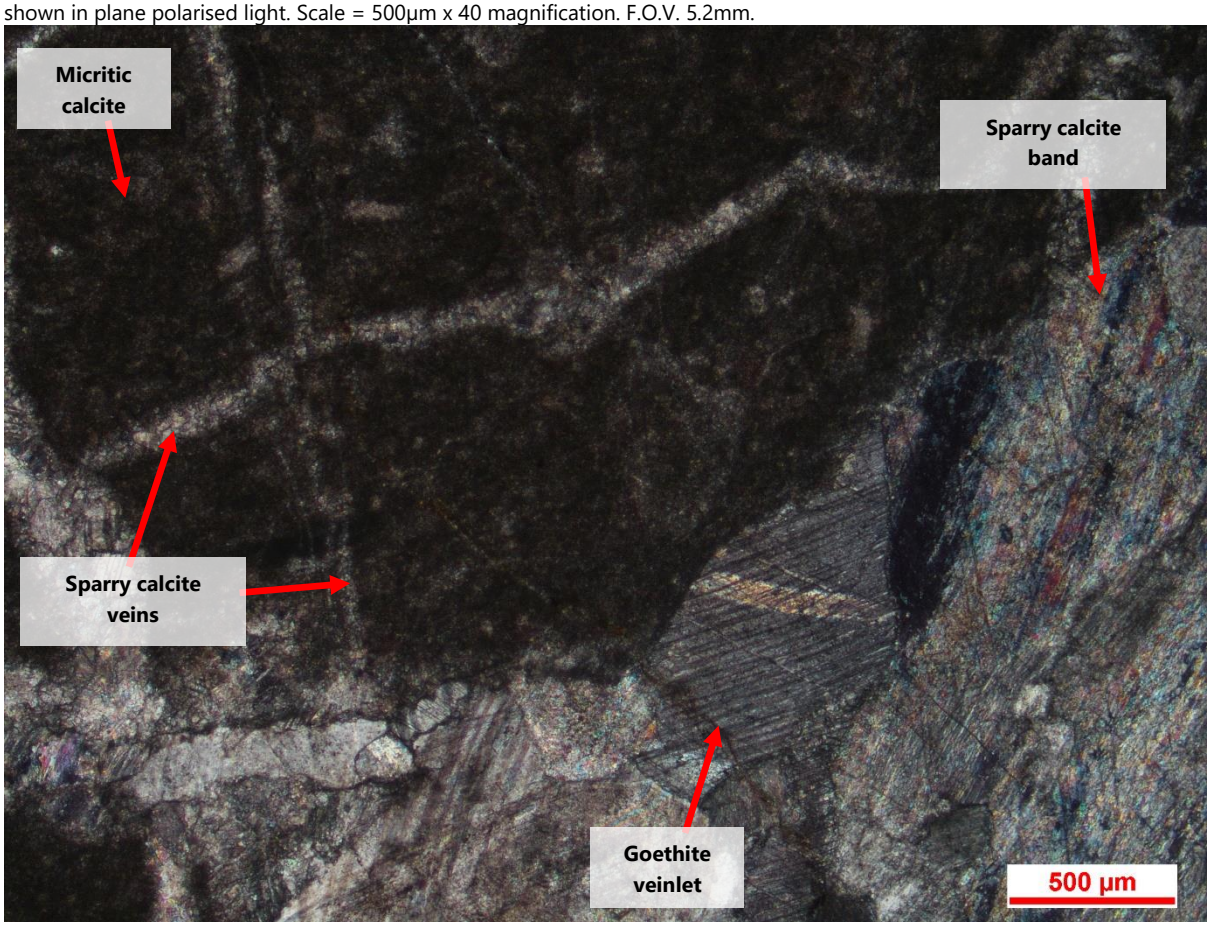


Plate 6: The same image from **Plate 5** under crossed polarised light. Scale = 500µm x 40 magnification. F.O.V. 5.2mm.

Summary

The roadbase sample is identified as being derived from a limestone source rock. The limestone is considered hard, strong, and is expected to be durable. Pending material testing, aggregate produced from this rock is regarded as suitable for use as coarse aggregate in concrete, unbound pavements, cover aggregate, graded asphalt and gabion/revetment. The sample is expected to perform well as roadbase. Extensive crushing to produce manufactured sand may submit elevated goethite particles but is otherwise considered suitable for use as fine aggregate in concrete.

For engineering purposes, the source rock may be summarised as:

- A **limestone**, a carbonate sedimentary rock.
- Slightly weathered with abundant goethitic fines, **non-porous** and without voids or extensive internal fracturing.
- Predominantly composed of **robust calcite (93%)**, with 7% weak goethite.
- Containing no free silica.
- Assessed as **innocuous in regard to ASR** in concrete.
- **Hard**, of predicted **high strength** and predicted to be **durable**.

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Petrographic Inspection Report

Prepared for:	Superior Quarry Testing
Purchase Order:	329
Material Source:	Graymont (Australia) Pty Ltd – Calliope
Sample Type:	Source Rock – Coarse Aggregate
Sample Number:	7596
Date Sampled:	01/12/2022
Date of Inspection:	01/02/2023
Report Issued:	03/03/2023
Project/ File Ref.:	P2022_220_01

Author: **Mathew Beddard (BSc)**

Petrologist
Groundwork Plus

Reviewer: **Rod Huntley (BSc, M.App.Sc, M.Eng)**
Principal Resource Consultant
Groundwork Plus

Enquiries regarding the content of this report should be directed to Groundwork Plus 07 3871 0411*. Samples are disposed of after 3 months from the date of report. Thin sections will remain on site indefinitely. The analysis is based on a limited number of thin sections and sample provided by client, further investigation may be required. Interpretations are specific to the sample examined only.*

Executive Summary

Classification: Limestone

For Engineering Purposes AS 2758.1: Coarse aggregate derived from carbonate sedimentary rock

Key Material Risk: Negligible risk

Table 1 – Summary of Sample's Compositional Characteristics

Compositional Features	%	Comments
Robust Phases	99	**Major (>20%):** calcite; **trace (<1%):** opaques
Weak Phases	1	**Minor (1-5%):** goethite
Clays	0	None observed
Micas	0	None observed
Sulphides	0	None observed
Carbonates	99	Calcite
Textural Features	**Yes/ No**	
Fracturing/veins	Yes	Abundant diagenetic sparry calcite veins. Minor goethite veins. No fractures observed
Voids	No	None observed
Free Silica	**%**	
Unstrained quartz	0	None observed
Optically strained quartz	0	None observed
Microcrystalline quartz	0	None observed
Siliceous volcanic glass	0	None observed
Opaline/chalcedonic quartz	0	None observed
Total	0	

Table 2 – Risk Rating for Specific Applications and Material Characteristics

Specific Application	Low	Mod	High	Comments
Coarse Aggregate in Concrete (MRTS70)	✓			Texturally isolated secondary/weak phases unlikely to cause deleterious reactions or significantly increase water demand in concrete
Manufactured Sand	✓			Expected to produce quality manufactured carbonate sand
Aggregate Unbound Pavements (MRTS05)	✓			Suitable hardness, strength, and durability
Cover Aggregate (MRTS22)	✓			Suitable hardness, strength, and durability
Graded Asphalt Aggregate (MRTS101)	✓			Suitable hardness, strength, and durability
Gabion/Revetment	✓			Suitable hardness, strength, and durability
Material Characteristics	**Low**	**Mod**	**High**	**Comments**
Hardness	✓			Hard
Strength	✓			Strong
Durability	✓			Durable
ACR in concrete	✓			Innocuous. No dolomite detected
ASR in concrete	✓			Innocuous. No reactive silica detected

Introduction

This report provides the results of a general petrographic assessment of an aggregate sample, which was submitted to the Groundwork Plus petrographic laboratory, and describes the method and standards used to assess the sample. The supplied sample was sampled by the client and sent to the Groundwork Plus petrographic facility. The thin section was prepared and analysed by Groundwork Plus with instructions from the client to conduct petrographic testing to ASTM C295 and recommend further testing if significant deleterious characteristics are identified pursuant to Clause 16.3 of this standard. The provided modal mineral percentages relate to the supplied sample which is understood to be representative of material on site. Assessment regarding the Alkali-Silica Reactivity (ASR) potential of the aggregate has been advised by SA HB 79-2015. Communication of findings are advised by AS 1726-2017 Geotechnical Site Investigations.

Methodology

The petrographic assessment of the slide is carried out using a Nikon polarising microscope equipped with a digital camera at the Groundwork Plus petrographic laboratory. Photographs of the hand specimen and thin section photomicrographs showing grain sizes and any particular aspects of the minerals are included as part of the report (**Plates 1** to **6**). Modal analysis is conducted on the sample using a Pelcon automatic point counter on at least 200 points (**Table 3 – Modal Analysis of Minerals**).

The petrology assessment is based on:

- ASTM C 295 – 2019 Standard Guide for Petrographic Examination of Aggregates for Concrete.
- AS 2758.1 – 2014 Aggregates and Rock for Engineering Purposes Part 1: Concrete Aggregates (Appendix B).
- AS 2758.2 – 2014 Aggregates and Rock for Engineering Purposes Part 2: Aggregate for sprayed bituminous surfacing.
- AS 2758.4 – 2014 Aggregates and Rock for Engineering Purposes Part 4: Aggregate for gabion baskets and wire mattresses.
- AS 2758.5 – 2014 Aggregates and Rock for Engineering Purposes Part 5: Asphalt Aggregates.
- AS 2758.6 – 2014 Aggregates and Rock for Engineering Purposes Part 6: Guidelines for the specification of Armourstone.
- The accepted definition of free silica is set out in the Queensland Department of Transport and Main Roads Test Method Q188, and tested pursuant to guidelines set in Standards Australia HB 79-2015 Alkali-Aggregate Reaction - Guidelines on Minimising the Risk of Damage to Concrete Structure in Australia - Cement and Concrete Association of Australia and Standards Australia.

Hand Specimen Description

In hand specimen, the sample is identified as a coarse aggregate derived from a **limestone**, a carbonate sedimentary rock.

The sample is composed of 5mm- to 20mm-sized particles. Particles are subangular to very angular, with low sphericity. The particles are an overall light to medium grey colour, with minimal variation. The shade of grey varies according to calcite texture, with micritic calcite being darker than sparry calcite. The particles react strongly with testing acid indicating a calcite composition. Rare ferruginous staining is observed on the faces of a minor abundance of particles.

The aggregate particles are regarded as strong and hard, with competent faces. No fractures or voids are observed. No sulphides are observed and the sample is not appreciably magnetic.

Plate 1: Photograph of the sample as provided.

Plate 2: Photograph of sample when wetted.

Thin Section Description

A mode base on a count of at least 200 widely spaced points is shown in **Table 3 - Modal Analysis of Minerals**. Robust minerals make up 99% of the sample and include calcite with trace opaques. Weak minerals make up 1% of the sample and include goethite.

The limestone shows textures consistent with classification as a mudstone with minor wackestone regions. Diagenetic alteration has seen replacement of micritic calcite with sparry calcite veins and bands.

Table 3 - Modal Analysis of Minerals

Robust Minerals	Mode (%)	Comments
Calcite (micritic)	51	Calcite showing massive, micritic texture. Also includes rare bioclastic/wackestone texture
Calcite (sparry)	48	Calcite crystals showing sparry texture including twinning. Occurs as replacement of micrite.
Opaques	Trace	Trace, 0.05mm sized, rounded, opaque, magnetite crystals
Weak Minerals		
Goethite	1	Minor veins and veinlets, and disseminated orange ferruginous staining
Total	**100**	

The sample is almost entirely composed of calcite at 99%. Approximately 51% of the limestone is composed of micritic calcite, with 48% being sparry. The micritic calcite is regarded as the primary texture prior to replacement by sparry crystals during diagenesis. The micritic regions are typical of carbonate mudstones, with expansive regions of microcrystalline, massive calcite. In some areas, rare bioclasts are observed giving a more wackestone texture. Bioclasts include gastropods and bivalves. The distribution of sparry calcite is variable, with veinlets, veins, and large bands and patches observed. Some areas contain abundant crosscutting veins and veinlets; others are dominated by wide bands of sparry crystals. The remaining robust phase observed is trace opaque magnetite, which is disseminated throughout the sample as small, 0.05mm sized, rounded crystals.

Goethite forms 1% of the sample and is the only observed weak phase. Goethite occurs as ferruginous veins and veinlets. Minor patches of ferruginous staining are also observed. No dolomitisation of the limestone is observed.

Overall, the sample is considered hard, strong, and durable, and considered suitable for use as a calcareous aggregate in all applications. The aggregate is regarded as suitable for use as coarse aggregate in concrete, unbound pavements, cover aggregate, graded asphalt, and gabion/revetment. Extensive crushing is expected to produce a quality carbonate manufactured sand.

Free Silica Content

After conducting a modal analysis using the Pelcon automatic point counter on at least 200 points, the total free silica content was found to be 0%. The sample was found to contain **no reactive silica.**

According to Standards Australia HB 79-2015 and Department of Transport and Main Roads test method Q188, the provided aggregate is assessed as **innocuous in regard to ASR** in concrete.

Table 4 – Calculation of Alkali-Silica Reactivity Value

Mineral Phase	Abundance	Critical concentration	ASR Value
Reactive silica phases	0%	3.0% to 5.0%	0
		Total	**0**

Asbestiform Minerals

Asbestos can be defined mineralogically and by crystal habit. For the purposes of health screening asbestiform habit is relevant, which is defined as being hair-like (filiform) and flexible with a high aspect ratio. Based on the thin section constructed from the material supplied, the sample contains **no observable asbestiform minerals**.

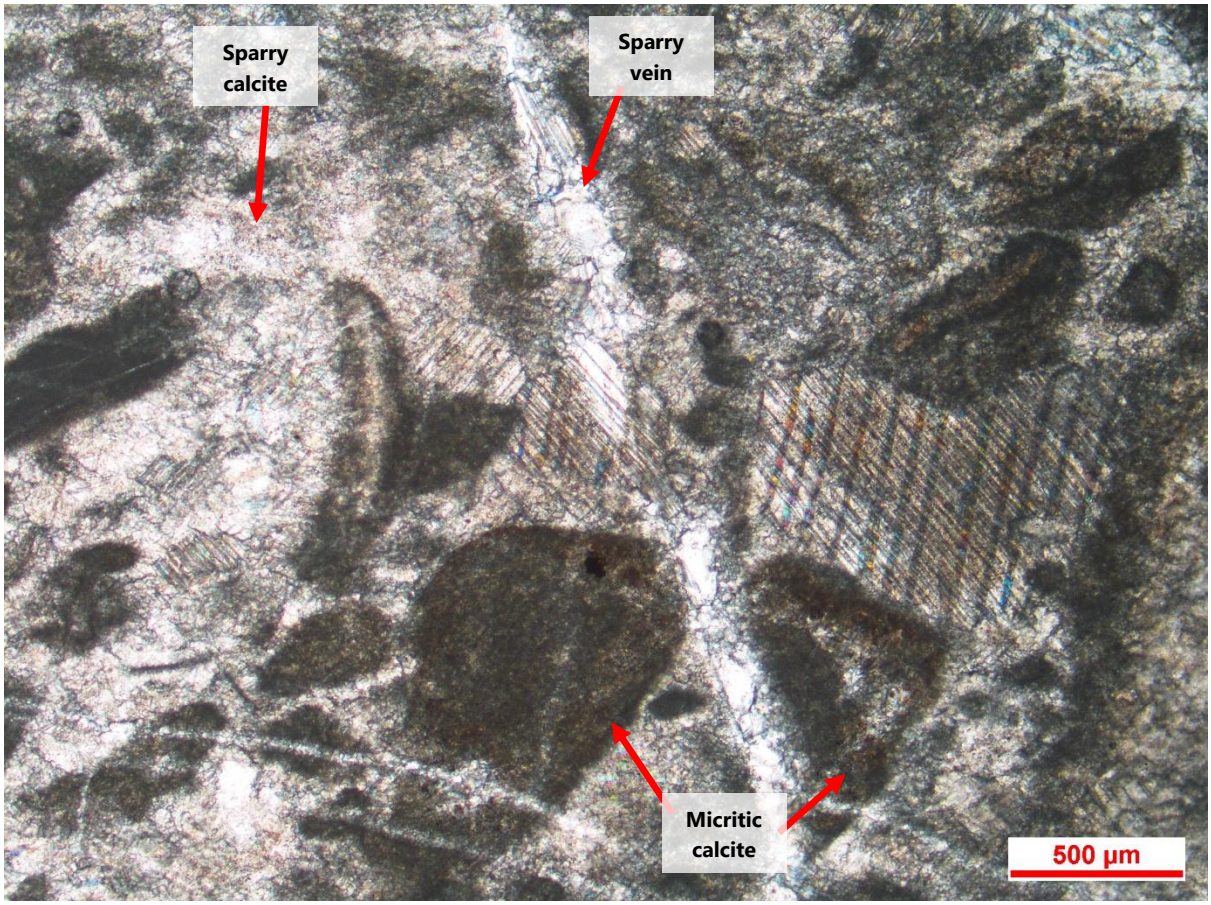

Plate 3: Microphotograph of the sample, showing remnant micritic bioclasts and regions surrounded by sparry calcite. Image shown in plane polarised light. Scale = 500µm x 40 magnification. F.O.V. 3.2mm.

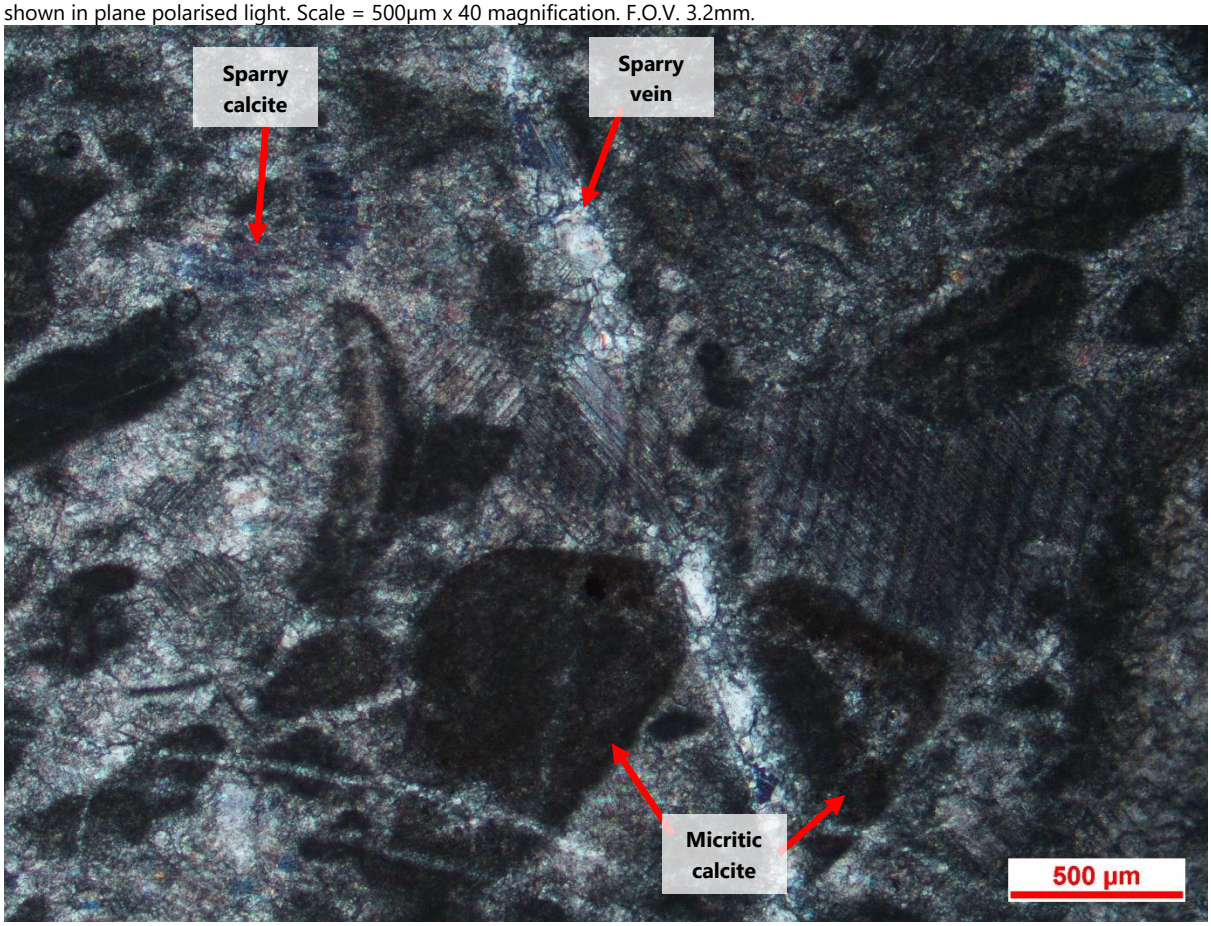

Plate 4: The same image from **Plate 3** under crossed polarised light. Scale = 500µm x 40 magnification. F.O.V. 3.2mm.

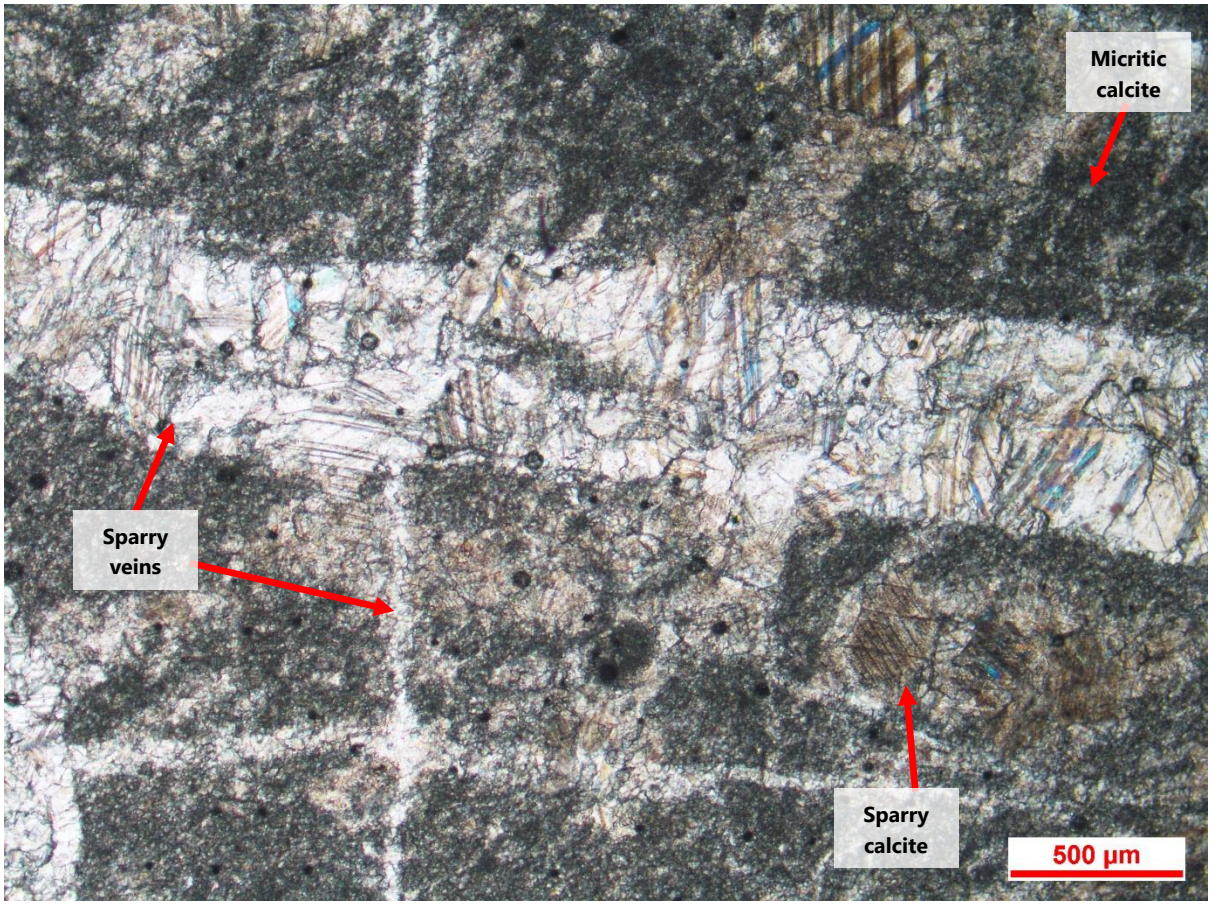

Plate 5: Microphotograph of the sample, showing crosscutting veins passing through micritic calcite. Image shown in plane polarised light. Scale = 500µm x 40 magnification. F.O.V. 3.2mm.

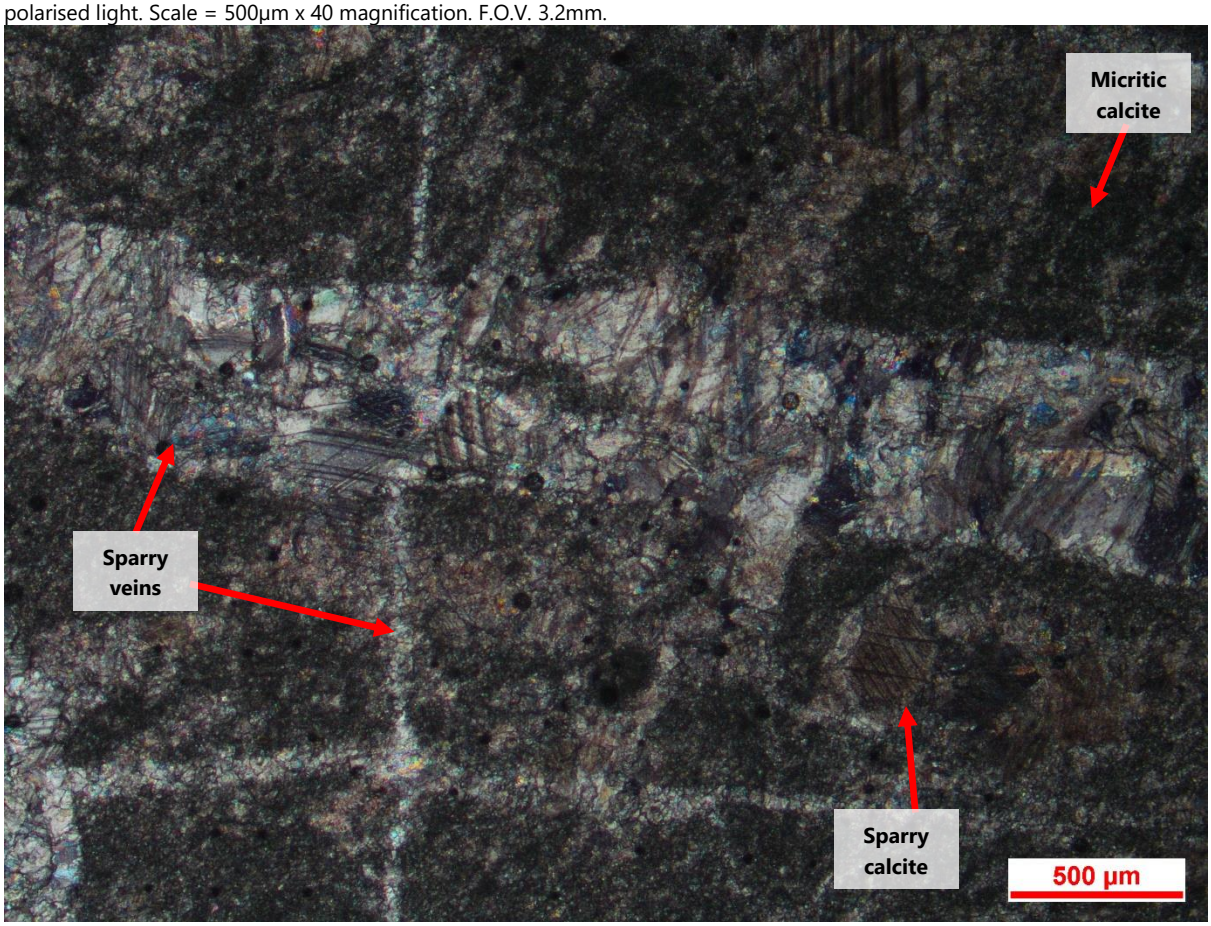

Plate 6: The same image from **Plate 5** under crossed polarised light. Scale = 500µm x 40 magnification. F.O.V. 3.2mm.

Summary

The sample is identified as a coarse aggregate derived from a limestone, a carbonate sedimentary rock type. The limestone is regarded as hard and strong, and is expected to be durable. Pending material testing, aggregate produced from this rock is regarded as suitable for use as coarse aggregate in concrete, unbound pavements, cover aggregate, graded asphalt, and gabion/revetment. Extensive crushing to produce manufactured sand is considered suitable for use as fine aggregate in concrete.

For engineering purposes, the rock may be summarised as:

- A **limestone**, a carbonate sedimentary rock.
- Mostly unweathered, **non-porous** and without voids or extensive internal fracturing.
- Predominantly composed of **robust calcite (99%)**, with 1% weak phases (goethite).
- Containing no free silica.
- Assessed as **innocuous in regard to ASR** in concrete.
- **Hard**, of predicted **high strength** and predicted to be **durable**.

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PETROGRAPHIC REPORT ON A 75-150 GABION ROCK (GL23-8830A) FROM GRAYMONT TARAGOOLA QUARRY

prepared for

BUTLER PARTNERS (REGIONAL)

Purchase Order: BPG4870

Invoice Number: G202307519

Client Ref: Simone Offord

Issued by

C. C. Angus
BSc, BA (Hons)
11 July 2023

Reviewed by

A.G. Christy
MA PhD FMinSoc
11 July 2023

Sample ID: GL23-8830A **Date Sampled**: 17/05/2023

Geo Sample ID: G23050111 **Date Received**: 24/05/2023

Product Type: 75-150 Gabion Rock

Sample Location: Graymont Taragoola Quarry

Project: G19-121A – Quarry Quality Testing – MS24 Taragoola Rd, Calliope, QLD

Work Requested Petrographic analysis in relation to suitability for use as concrete aggregate; petrographic analysis in relation to potential for alkali-silica reactivity.

Methods Account taken of ASTM C 295 Standard Guide for *Petrographic Assessment of Aggregates for Concrete*, the AS2758.1 – 2014 *Aggregates and rock for engineering purposes part 1; Concrete aggregates (Appendix B)*, the AS1141 Standard Guide for the *Method for sampling and testing aggregates*, of the content of the 2015 joint publication of the Cement and Concrete Association of Australia and Standards Australia, entitled (HB 79-2015) *Alkali Aggregate Reaction - Guidelines on Minimising the Risk of Damage to Concrete Structures in Australia* and of the Queensland Transport and Main Roads Materials Testing Manual – Part 6 (September, 2020) *Test Method Q188: Petrographic assessment of aggregates.*

Identification Limestone

Description

The aggregate sample consisted of about 20 kg of angular and sub-angular, medium light-grey, finely crystalline limestone which is unweathered to less commonly slightly weathered (some fragments display brown limonitic and reddish hematitic staining), and apparently robust. A thin coating of white dust is easily removed by washing a small sub-sample.

Figure 1: Image of a washed subsample supplied aggregate.

Mineralogy

A thin section was prepared to permit microscopic examination in transmitted polarized light of a fragment. An approximate composition, expressed in volume percent and based on a brief count of 100 widely spaced points falling within the sectioned random fragments, is:

96%	calcite (composed of 47% micritic calcite in the matrix and 49% sparry coarser calcite in veins)
<1%	quartz grains
4%	carbonaceous matter
<1%	sericite/illite
<1%	secondary iron oxide (limonite/goethite and hematite)

In thin section the rock fragments are seen to consist of abundantly veined, finely crystalline limestone; some of the fragments are fossiliferous.

The fragments display carbonate textures, now largely overprinted by fine mosaic recrystallization and cut by numerous veins of mobilized calcite; ghosted remnants of fossils are observed in some fragments. Matrix carbonate is of finely crystalline, micritic style (finer and slightly muddy), around 0.005 to 0.02 mm in grainsize. Numerous and irregular veins around 0.02 to several millimetres wide carry sparry calcite with a grainsize up to at least 2.5 mm associated with a little limonite/goethite and hematite. Some quite thin and complexly shaped stylolites are delineated by fine carbonaceous matter which is accompanied or replaced by limonite.

Normative Requirements

As per the Queensland Department of Main Roads Test Method Q188, the following normative requirements have been tabulated.

Requirement	Result
Quartz Content	<1%
Alkali Silica Reactivity (ASR) Potential[1]	Innocuous
Asbestos[2]	None observed
High sodium/potassium minerals	None observed
Sulphide content	None observed
Clays and moisture sensitive materials	4%
Carbonate Content	96%
Glass Content	None observed

[1] See ASR potential calculation below

[2] Not completed to the 2004 *Method for the Qualitative Identification of Asbestos in Bulk Samples*

Comments and Interpretations

This supplied 75-150 Gabion Rock sample (GL23-8830A) from Graymount Taragoola Quarry is interpreted to represent limestone, a biochemical sedimentary rock which has been indurated and rendered non-porous by diagenetic, fine recrystallization and by abundant veining by mobilized and coarsened calcite.

For engineering purposes, the rock in the supplied aggregate sample may be summarised as:

- **limestone**, a biochemical sedimentary rock
- almost pure calcium carbonate (carrying 4% of other minerals)
- finely recrystallised
- abundantly veined
- non-porous
- unweathered and less commonly slightly weathered
- having a **hardness of only about 3** on the Mohs hardness scale (in contrast to a Mohs hardness of 7 for quartz) making it **moderately robust**.
- soluble in even dilute or weak, natural or synthetic acids

The product is interpreted to be **innocuous in relation to both alkali-silica**: it lacks the free silica necessary for deleterious alkali-silica reaction.

Optical differentiation between calcite and dolomite is inexact. The sample has the **potential to be reactive in relation to alkali-carbonate reactivity**. It is recommended that XRD analysis be carried out if detailed separation of carbonate species is required.

Thus, limestone equivalent to the supplied aggregate sample is predicted to be **suitable for use in concrete aggregate**, provided that it is not exposed to heavy abrasion and not exposed to attack by acids. It is also unsuitable for concrete intended for specialised high-temperature applications, since carbonates can decompose explosively under such conditions.

Free Silica Content

Apparently less than 1%.

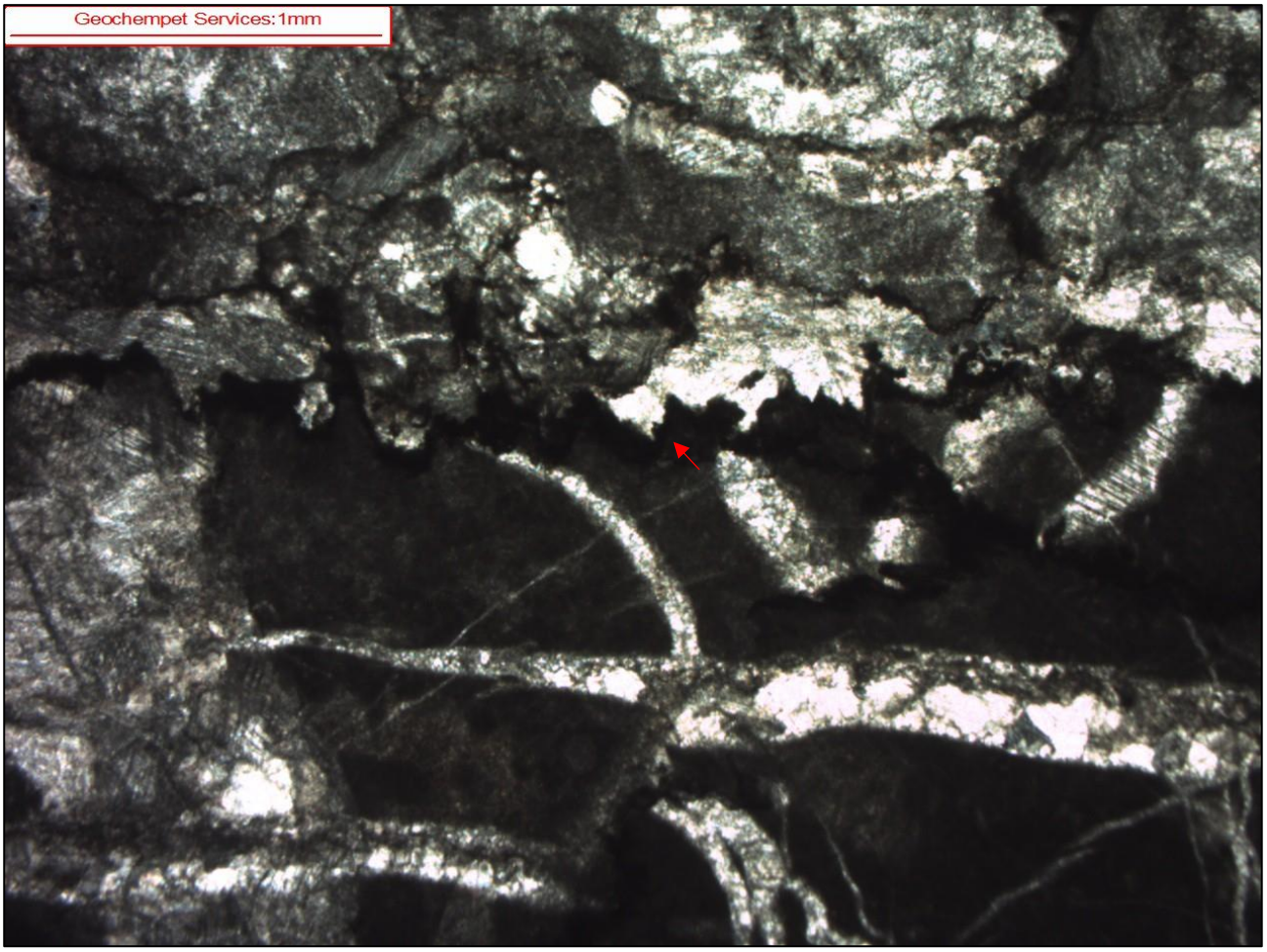

Figure 2: Micrograph taken at low magnification (2× objective) with transmitted cross-polarised light of a limestone fragment. Note the sparry calcite hosted within veins, the micritic calcite in the groundmass and stylolites carrying carbonaceous matter indicated by the red arrow.

Material Test Report

Superior Quarry Testing Pty Ltd
ABN: 49 103 442 402
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Address: Unit 4/189 Anzac Avenue
Toowoomba Qld 4350
Phone: 0412 694 063
Email: mal@superiorquarrytesting.com

Client:	Graymont (Australia) Pty Ltd
	MS 24 Taragoola Road
	Calliope Qld 4680
Project:	Compliance

Report No:	**9611**
Issue No:	**1**

Sample Details

Sample Number:	8704
Client Reference:	-
Date Sampled:	14/6/2023
Date Received:	22/06/202320/6
Material Source:	Calliope
Material Type:	Source Rock - Coarse Aggregate
Specification:	-
Sampling Method:	Tested as Received
Sampled From:	-
Location:	-
Lot No:	232006
Sampled By:	Submitted By Client

NATA Accredited Laboratory Number:20085

ACCREDITED FOR TECHNICAL COMPETENCE

Approved Signatory: Mal Nicholls

Date of Issue: 11/07/2023

Accredited for compliance with ISO/IEC 17025 - Testing

Report Notes:

1. The results in this report relate only to the items tested.

2.The results in this test report apply to the sample as received. Sample information was provided by the client.

Testing Completed: 11/07/2023

Test Results

Test Method	Details	Results	Min	Max	Tar
AS1141.6.1	Particle Density Dry (t/m3)	**2.70**			
	Particle Density SSD (t/m3)	**2.71**			
	Apparent Particle Density (t/m3)	**2.72**			
	Water Absorption (%)	**0.2**			
AS1141.22	Nature of Bulk Sample	Crushed Rock			
	Nominal Size of Aggregate (mm)	20			
	Size Fraction of Test Portion (mm)	-13.2/+9.5			
	Dry Strength (kN)	**138**			
	Wet Strength (kN)	**133**			
	Wet/Dry Strength Variation (%)	**4**			
	Breakdown During Preparation	No			
	Size of Test Cylinder (mm)	150			
Q208B	Washington Degradation Factor	**34**			
AS1141.23	Los Angeles Value (%)	**26**			
	Selected Test Grading	B			
AS1141.24	Sodium Sulphate Soundness				
	Nature of Sample	Aggregate			
	19.0 - 13.2mm Loss (%)	0.2			
	13.2 - 9.5mm Loss (%)	0.3			
	9.5 - 4.75mm Loss (%)	0.5			
	Total Weighted Loss (%)	**0.2**			
AS1012.20.1	Qualitative Test- Positive/Negative	**Negative**			
	Chloride Content (%m/m)	**0.000**			
	Analysis Method	Volhard Titration			
AS1012.20.1	Qualitative Test- Positive/Negative	**Negative**			
	Sulfate Content - SO3 (%m/m)	**0.04**			
	Analysis Method	Gravimetric			

Comments: